

AUGUST 1989 \$1.95

Popular Mechanics

VOYAGER'S CLOSEUP
LOOK AT NEPTUNE THIS MONTH

CELEBRATION OF A CLASSIC

MUSTANG

Charming America For 25 Years

- History Of A Legend
- Comparison Test:
'64 1/2 GT vs. '89 GT
- Collecting And
Restoring For
Fun And Profit
- Plus A Fabulous
Shelby GT
Collector Poster
And More



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- Build Our High-Fashion
Drop-Leaf Table
- Saw Blade Sharpening
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How To Use Glass Blocks
For A Dramatic New Look

BIG LUXURY IN A SMALL PACKAGE

Offshore-Testing
4 Cuddy Cabin Boats



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Something great to look back on.**



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81 COVER STORY

The Ford Mustang has been charming America for 25 years, and on its silver anniversary, we celebrate its history.

—PM photo by Ron Hussey



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EDITOR'S NOTES

THINK IT'S EASY to find someone who will let you run the wheels off his classic Mustang GT convertible just because you want to do a magazine article? Believe me, it isn't. Which is why I had my good buddy Penn Lenson scouring all of Southern California, trying to find us just the right car for our salute to the Ford Mustang on its 25th anniversary. My requirements were stringent. It had to be a 1964½, one of the first Mustangs built. It had to be a GT convertible. And it had to be red (red cars on magazine covers sell best). Finally, with our deadline approaching, Lenson found the exact right car—at a Mustang reunion and car show at Knott's Berry Farm in Anaheim. Then there was the matter of convincing owner Neal Polan that we wanted to photograph his car for the cover of POPULAR MECHANICS. Sure, and your mother is Samantha Fox, too. After awhile, Polan was convinced that it was all legit and not just a scheme

to steal his prized possession. Thus, at the appointed time, at the appointed dry lake near Edwards Air Force Base, Polan and his Mustang showed up on the back of a car transporter. Model Alyson Acre was already there, and one look at her convinced Polan that this was going to be a good day. It was. As you can see from the photo on our cover and in this month's special Mustang section, Neal Polan's red convertible is a fine representative of the classic Mustang breed. And, by the way, it's a great advertisement for Polan's business—Affordable Classics Restoration Service in Torrance, California. Polan calls his operation "a hobby that turned into a business," adding that it's "the same kind of thing I've been doing since I was 18, except now I get paid for it." . . . On August 26, something of a miracle will occur. After traveling for 12 years and more than 2 billion miles, the *Voyager* spacecraft and the planet Neptune will meet in space. Engineers and scientists at the Jet Propulsion Laboratory in Pasadena, California, will maneuver the spacecraft to fly past within 3000 miles of Neptune's atmosphere—the closest approach to a planet ever for a spacecraft. To me, it's a mind-boggling event to comprehend. A little dot in space meets a giant planet 12 years later and gets within 3000 miles. The whole amazing story of this triumph of American space technology begins on page 51 of this issue. No doubt you'll be seeing pictures of Neptune on television and in other news media, sent back from *Voyager*. When you look at them, try to imagine the small miracle it took to obtain them. . . . I have to say it. I really love our Home And Shop Journal section. We began the section last February as a response from you readers telling us that you'd like all the home and shop editorial grouped together in the magazine to make it easier to find and follow. In readership surveys we've taken since February, it looks like Home And Shop Journal is a hit. This month's selection of features is no exception, ranging from a beautiful gateleg table project to circular saw blade sharpening to tool tests, and more. If you're not yet tuned in to our Home And Shop Journal, check out page 79. I think you'll like what you see. Till next time.



Alyson Acre, Neal Polan and PONY1.

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Joe Oldham

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LETTERS

Full Head Of Steam

WE COULDN'T help noticing a steam locomotive on the cover of the May 1989 issue of **POPULAR MECHANICS**. We enjoyed your coverage of our favorite topic, and thought you might like to know that a small magazine is dedicated to chronicling the activities of steam locomotives, primarily those in North America. *Steam Digest*, which we subtitle "The Magazine Of Operating Steam Locomotives," is a bimonthly, with subscriptions priced at \$16 a year for U.S. readers.

THOMAS R. SCHULTZ
STEAM DIGEST
P.O. BOX 811009
CHICAGO, IL 60681-1009

I was very interested in your article about the great comeback of steam trains, and wanted you and PM readers to know that the Shiawassee Valley Railroad Co. has brought back one of the great steam engines of the past. They offer rides and have the only "backshop" in Michigan; all the equipment is from the days of steam trains. The next excursions between Owosso, Henderson, Chesaning and St. Charles will be July 14-15, then late summer and fall: Sept. 2-4, Oct. 14-15.

Keep up the good work, and excellent articles, because I know your readers will love you for it.

CLIFTON TOBIAS
PERRY, MI

I very much enjoyed reading your May '89 issue, with its focus on "The American Adventure," and commend you for the many talented individuals you brought together for this particular publication. It's an issue to be proud of!

MARK O. HATFIELD
U.S. SENATE
WASHINGTON, D.C.



The May '89 double issue featured steam locomotives and "The American Adventure."

"The American Adventure" section in your May '89 issue was excellent. The writing, particularly the pieces by Updike and Halberstam, was just superb. Please keep it up.

RICHARD A. SPITZER, M.D.
PASADENA, CA

One-On-One

This note is to thank you for your kindness in providing me with the information on conversion of film to VCR tape on the PM Hotlines telephone last week, and in sending me the back PM articles. It is so rare nowadays to get this kind of prompt, courteous and helpful service, that I felt that I had to acknowledge this by letter.

BERNARD LOEV, Ph.D.
SCARSDALE, NY

Tailgating Solution

I enjoyed the car test article on the ASC/McLaren Mustang. Being the owner of a white McLaren since last August, I could relate to all of the joys and tribulations of driving this beautiful automobile. I thought you might be interested in my solution to the tailgaters trying to read the name on the back bumper. It's a vanity plate.

Drivers behind read the license tag MCLAREN and then check the imprint on the bumper ASC/MCLAREN. They still are not sure what it is, but at least they now have a name for it.

BETTY E. FOSTER
VIENNA, VA

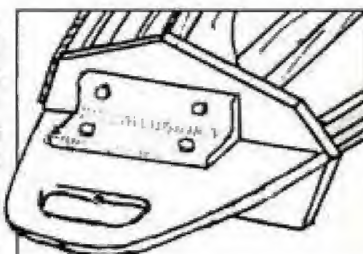
A Better Boat

I just completed my HydroRunner using your plans in the August '88 issue ("Fast Fun," page 80).

I made a few changes as I went along. The most noticeable is the integral handgrip in the nose. This makes it easier to pull the boat up on a trailer or the beach. I also added a stainless-steel pin through the center of the grip lengthwise to allow for a convenient tiedown point at the nose.

Another change was to add two bow eye tiedowns on the transom. I chose the bow eye's because they look better than stern tiedown eyes. They come in very handy as lifting points. In fact, I actually suspended the boat by the bow pin and stern tiedown eyes for painting.

Some other details include: Epoxy-Plus by Clark Craft in place of fiberglass resin (easier to use and totally water-



Reader Dalton built a handgrip into his HydroRunner's bow.

proof), fuel tank integral part of the hull (like wet-wing construction on homebuilt aircraft) and handlebars from an off-road Honda 750.

Thanks for a great set of plans!

JACK W. DALTON
HOLTWOOD, PA

Can-Do Guy

I just had to drop you a little note to let you know that the plan I sent for recently (Bookcase Wall plan PM-1008) couldn't have been better. All of the directions were clear and easy to understand, right down to the serial number of the type of hinges to buy and the color codes of the paint. Here is a picture to prove that even a ham-and-egger like me can do a good job with the right tools and good plans.

PATRICK WALSH
SWANSEA, MA



The Bookcase Wall is featured in the PM Plans And Ideas catalog.

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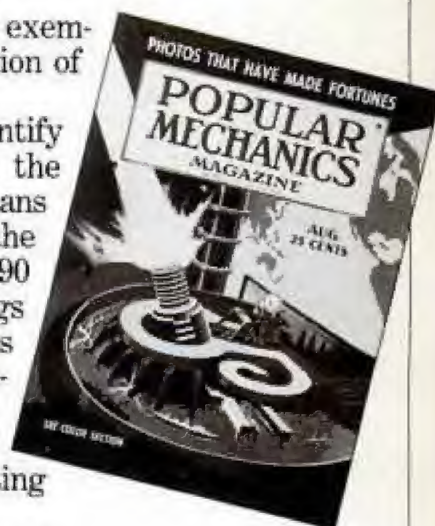
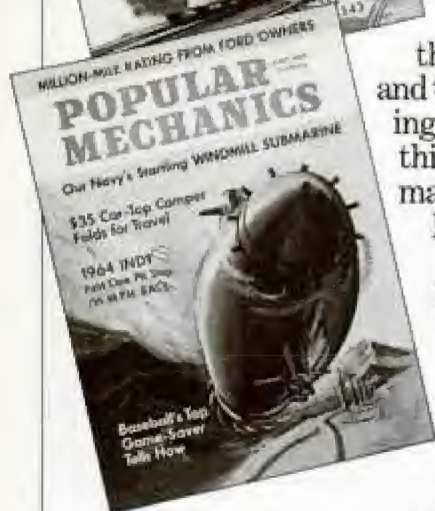
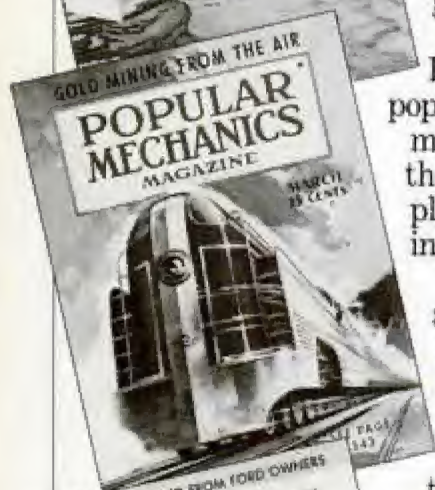
We need your help.

The Henry Ford Museum & Greenfield Village and POPULAR MECHANICS need your help. To commemorate the 90th anniversary of the magazine, Henry Ford Museum and POPULAR MECHANICS are planning to collaborate on an exhibit on the history of the popular culture of American ingenuity and mechanical knowledge, as reflected in POPULAR MECHANICS.

Because of its important role in popularizing innovation and spreading mechanical know-how throughout the 20th century, the history of our magazine exemplifies the deep and lasting American tradition of ingenuity and problem-solving.

We need the help of all you readers to identify and locate examples of the inventions, the projects, the models, the cover art and the plans for the countless features that have filled the pages of POPULAR MECHANICS for the past 90 years. We are interested in both those things that predicted a future that never came to pass and those things that were so successful in becoming a part of daily life that we no longer even think about them. Please help us locate this material so we can create a timely and exciting historical exhibit.

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TIME MACHINE

75 YEARS AGO: AUGUST 1914



Monument Makers

PM has long served as a paean to craftsmanship—a tradition stretching back 87 years. Our 1914 cover saluted the men who shaped the statuary on top of New York City's newly built Grand Central Station. Deftly wielding hammer and chisel, workmen created a soaring cornice piece 65 ft. wide and 50 ft. high. Our 20th-century reliance on efficient transportation was exemplified by the monument's principal figure, Mercury, messenger of the Gods.

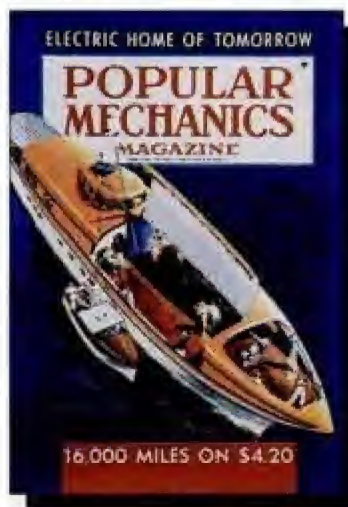
Sikorsky Takes Wing

Long before acquiring the title Father of the Helicopter, Igor Sikorsky gained fame as an aeronautical pioneer in Czarist Russia. Si-

korsky designed and built what was, up until then, the world's largest passenger biplane. A wing-collared Sikorsky (below) took the controls for the maiden flight.



50 YEARS AGO: AUGUST 1939



The Great Designers

Anthony H.G. Fokker had already earned respect as an aircraft innovator. Our cover subject a half-century ago showed the results of Fokker's efforts as marine architect. His 110-ft. motoryacht, constructed of Philippine mahogany, showed an unmistakable aviation influence. An enclosed pilothouse with wraparound viewports resembled the flight deck of once and future air transports. Aerodynamic streamlining, much in vogue, characterized the yacht's profile.

Kitchen Magic

Way back in '39, we foresaw a wondrous age when your food would be cooked by radiowaves—today's microwaves—instead of in a standard convection oven. Westinghouse engineers had already succeeded in reducing the time it took to cook a ham from 4 hours to 40 minutes. It took new materials and manufacturing economies 50 years to take microwave cookery from the laboratory to the marketplace. The device appeared in a study of the modern

kitchen—transformed into a sanctuary of ease and efficiency by appliances then in development.



25 YEARS AGO: AUGUST 1964



Up, Up And Away

Always willing to speculate on the potential of emerging technologies—who can forget the helicopter in every garage?—PM's cover subject 25 years ago boldly chronicled a new levitation machine powered by charged ions. The Ionocraft test bed flew on an air cushion created when negatively charged air particles rushed toward positively charged spikes on the machine's spidery framework. Changing the voltage served as a throttle and directional control.

Sexiest Car Alive

Ford engineers called it the Mustang 1 GT, an American upstart on European road-

racing circuits capable of 200-mph speeds. Pushed by a 256-in. prototype V8, it also demonstrated unusual driver friendliness with a prototype pneumatic seat mover and an adjustable steering column. **PM**



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TECH UPDATE

News Of Tomorrow's Technology Today

Stealth Fighter Photographed Over Nevada

The supersecret Lockheed F-117A Stealth fighter flies over Tonopah, Nevada. The three views reveal the fighter's surprising 68° wing sweep. Inset views show the F-117A in silhouette and (right) in formation with what appears to be a Northrop T-38 Talon.



TONOPAH, NV—Parked in a gas station in this remote town, Byron Aughenbaugh heard a faint, high-pitched whine overhead. Suspecting it was different from the combat aircraft that routinely train in the area, he reached for his camera, a Minolta X-700 with a 500mm Vivitar zoom. The result was the clearest photographs yet of the supersecret F-117A Stealth fighter taken by a civilian.

Aughenbaugh's photos reveal the extreme sweep of the aircraft's wings—about 68°—which was not evident in earlier official views. This would yield an unusually low aspect ratio for a subsonic plane, which the F-117A is believed to be. The resulting aerodynamic penalty might be made up for by a smaller radar profile and the ability to carry it aboard C-5s.

The shape of the wing also reveals a relatively high surface area, which would mean light wing loading. Experts estimate that the plane could take off and land at speeds of around 150 knots.

The plane is believed to be powered by two nonafterburning General Electric F404 engines, producing 11,000 pounds of thrust apiece. Speeds, estimated from ground observations, are around Mach .8.

Its composite-sheathed metal structure makes it difficult to detect by radar. External hard points for munitions are absent, enhancing the aircraft's stealthy profile, and the outlines of what appear to be a

bomb bay are visible, suggesting an internal weapons load of gravity bombs or short-range missiles. The

fighter is reportedly designed to knock out high-value missile, radar and command targets.

Highlights This Month

- **Strategic Warfare**—Advanced cruise missiles give our bombers standoff flexibility.
- **Composites**—Cloth and resin replace rivets in the next-generation aircraft.
- **Minimachines**—First application of 21st century "microbots."
- **Planetary Rovers**—New designs for autonomous lunar, Martian vehicles.
- **SuperSWATH**—A new kind of ship design promotes stability, range.
- **Air Power**—Propelling tomorrow's VTOL aircraft will require revolutionary engines.
- **Space Station Freedom**—First operational components assembled.

Editor: Tim Cole
Assistant Editor: Abe Danc
Contributors: Chris Caswell,
Mike Dillon, William Slurz

Drag Cut For Big Rigs

MOUNTAIN VIEW, CA—A simple aerodynamic device could save a billion gallons of fuel annually if widely adopted by American truckers.

Developed in a NASA Ames wind tunnel, it has four flat plates that bend airflow inward so it closes smoothly



around the truck's stern. The converging flow pressurizes the drag-producing, low-pressure zone in the truck's wake.



Plates (above right) reduce reverse-flow region shown in computer graphic (above).

First Look At Stealth Missile

WRIGHT-PATTERSON AFB, OH—The Air Force has released a photo of the highly sensitive AGM-129 advanced cruise missile (ACM). It was the last part of the stealth arsenal still under wraps.

Shown slung beneath a B-52 in a captive carry flight somewhere over the U.S., the missile is intended to strengthen the bomber leg of the strategic triad by sneaking warheads under Soviet radar.



ACMs are mounted on underwing pylons capable of holding up to six each.

Undisclosed advances in range, accuracy, flexibility and stealth distinguish the ACM from its predecessor, the AGM-86B, now in service with SAC.

Composites Give Wing To New Aircraft Design

NEW YORK, NY—Military and civil aviation designers are making strides toward developing composite materials which replace metal and rivets with bolts of cloth and synthetic adhesives.

Mass production has begun on the first pressurized, all-composite aircraft to receive FAA certification—the Beechcraft Starship.

Except for titanium reinforcements at the forward wing, landing-gear and tipsail attachment points, the 8-passenger business turboprop's basic structure is entirely of epoxy-impregnated carbon fiber around a phenolic-impregnated aramid honeycomb core.

In addition to weight savings and ease of manufacturing, the composites make possible a radical new de-

sign. Moving the main wing and engines to the rear improves performance, reduces cabin noise and gives passengers an unobstructed view. A variable-geometry forward wing compensates for changes in pitch balance caused by main-wing flap operation. Vertical-stabilizer functions are handled by 8-ft. wingtip tipsails.

The bottom line is jet-like performance. Cruising speed: 387 mph. Max rate of climb: 3250 fpm. Meanwhile, the Air Force is performing the first long-term tests of advanced thermoplastic and



T-38 with avionics bay access panel (in green area).

thermoset composites on supersonic aircraft. Data on composite parts added to 48 F-5Es and T-38s will be collected to determine how the materials could shape the fighters of the future.



Starship (below) demanded new production techniques. Ultrasonic C-Scanner (below right) detects wing flaws, and 5-axis milling machine (bottom right) shapes nacelle form. Worker (left) adds Pitot plumbing.



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Micromotor Undergoes Tests

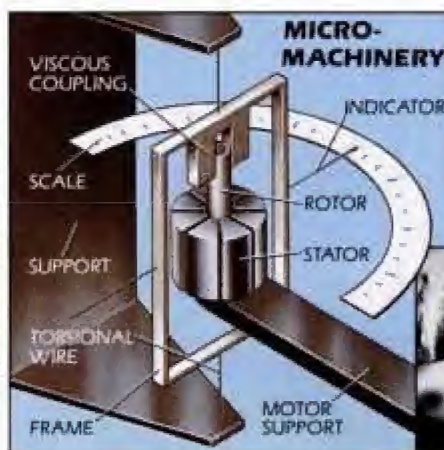
SALT LAKE CITY, UT—An electric motor just a few human hairs wide has proven its capacity for sustained high-speed running at the University of Utah.

Called a wobble motor, it has a cylindrical rotor loosely fitted into a sleeve made up of eight stator segments. The rotor rolls, or wobbles, around the internal circumference of the sleeve in response to electrostatic forces

from the stator.

A tiny dynamometer and tachometer have been designed to test torque, rpm and wobbles per minute (wpm). As of this writing, the motor has completed 6.7 billion wobbles in 14 weeks of nonstop use.

The motor's parts were fabricated from stainless steel and aluminum by computer-controlled electrodischarge machining.



Microdynamometer (left) is linked to motor by viscous coupling. Readings result when frame twists torsion wires. Micrograph (below) shows motor and dime's edge.

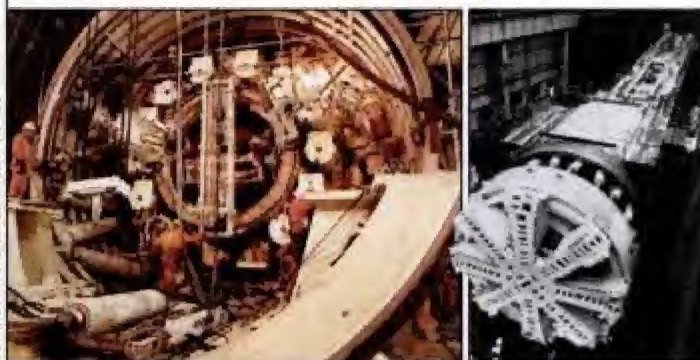


Chunnel Drill Grinds Forward

FOLKESTONE, ENGLAND—One hundred meters below the English Channel, a pair of 1500-metric-ton tunneling machines are laboring toward the continent. Guided by satellites and lasers, the machines will meet their French counterparts in late 1990, completing the service tunnel that will link the Chunnel's two running tunnels.

As the machines proceed through the chalk marl of the channel bottom, they lay down segments of precast concrete, shoring up the tunnel. By the time they finish, 7.5 million cubic meters of earth will have been excavated, and used to form a sea wall at Folkestone.

Breakthrough of the last running tunnel is scheduled for mid 1991.



Aft part of mole with conveyors for removing marl and other material is seen (left). Cutting face is at right.

Teleoperated Rovers Readied For Space Flights

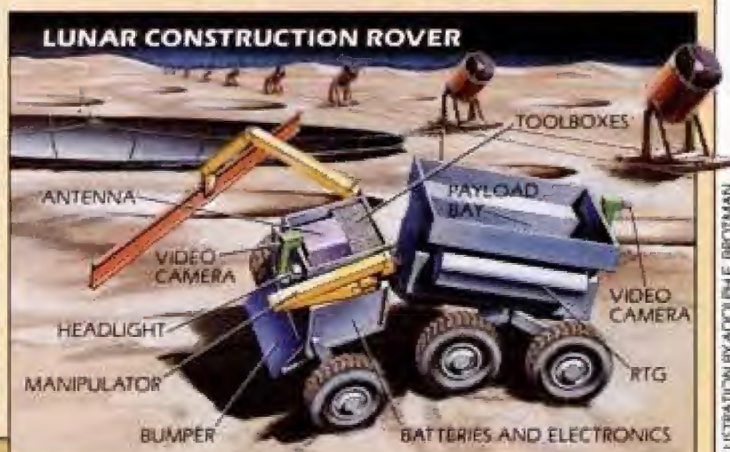
NEW YORK, NY—Designs are under study for unmanned vehicles that will be the workhorses of future missions to Mars and the Moon.

Battelle National Laboratories, and NASA's Jet Propulsion Laboratories are both developing concepts with partially autonomous guidance systems, and electric motors powered by radioisotope thermoelectric generators (RTGs), the same type of powerplant that provides

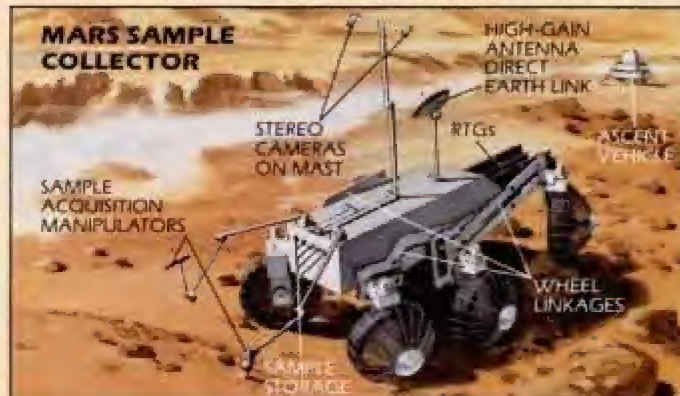
electricity to deep space probes.

The Battelle concept would be used in construction of the Lunar Observatory, scheduled for around 2005. The 3100-pound rover would carry parts for telescope arrays from freighter rockets, then erect them with tools held by its manipulator arms.

Although controlled from Earth, the vehicle is equipped to exercise some discretion. Computerized sensors help it



Guided by orbiting imager, JPL rover picks up and analyzes samples.



Battelle rover carries components to build lunar telescope.

around obstacles, and an inertial guidance system calibrated by laser triangulation will keep it oriented.

For the Mars Sample and Return Mission, scheduled for 1998, JPL has conceived a 6-wheeled rover with an articulated body. The rover would spend about 300 days collecting rocks and taking core samples.

Because it takes 2 hours

for radio signals to reach Mars from Earth, new remote-control techniques must be developed. One, called computer-aided remote driving, would rely on Earth-based analysis of pictures from the rover's video cameras to pick out a path up to 250 ft. ahead. As the rover moves forward, a laser range finder spots obstacles not previously accounted for.



Bow planes and bluff stern ease passage of SWATH ship.

Most Efficient SWATH Yet

WILMINGTON, CA—A unique small waterplane hull (SWATH) trimaran bristling with novel hydrodynamic features is expected to ply the seas more easily than twin-hull SWATH ships.

Scheduled for winter launch, the 100-ft. *Theodore von Karman* boasts an estimated range of 7500 nautical miles on 13,800 gallons of fuel. By adding a pair of shallow-draft sponsons for stability, designer Calvin Gongwer was able to use an extremely slender center

hull. The resulting high length-to-beam ratio reduces wave drag.

Roll is prevented by keeping most of the hull's mass deep below the waterline. Pitch is converted to forward motion by a pair of hydraulically actuated bow planes.

The patented bluff after-section makes the usual long, smooth run into the propellers unnecessary, adding 20 percent to cargo room. Turbulence is avoided by using thin-disc actuator props, which pull water off stern.

New Propulsion Schemes Give Hover Planes A Lift

NEW YORK, NY—New solutions are being tested to the old problem of building a plane that combines fast-forward flight with short-field landing and takeoff ability.

NASA is testing a full-scale model of the E-7A, a short takeoff/vertical landing (STOVL) craft capable of supersonic speeds. The craft's STOVL capability comes from a pair of ejector augmenters at the wing roots and a vectorable ventral nozzle near the tail.

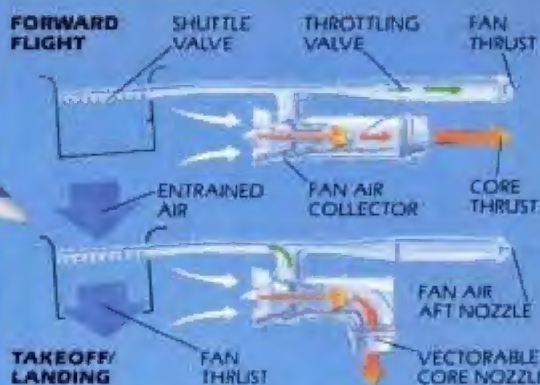
On liftoff, box-like ducts unfold under the ejectors and thrust from the engine's fan is directed through them. Intake doors open above the ejectors to let in augmenting air, which boosts thrust by a factor of 1.5 to 2.

At the same time, the en-



E-7A, shown in wind tunnel (left), will achieve vertical lift with ejector system (right).

FUTURE VERTICAL LIFT



gine's turbine core blasts through the downward-vectorable ventral nozzle.

To gain forward speed, the ejector ducts are gradually shut down, and the ventral

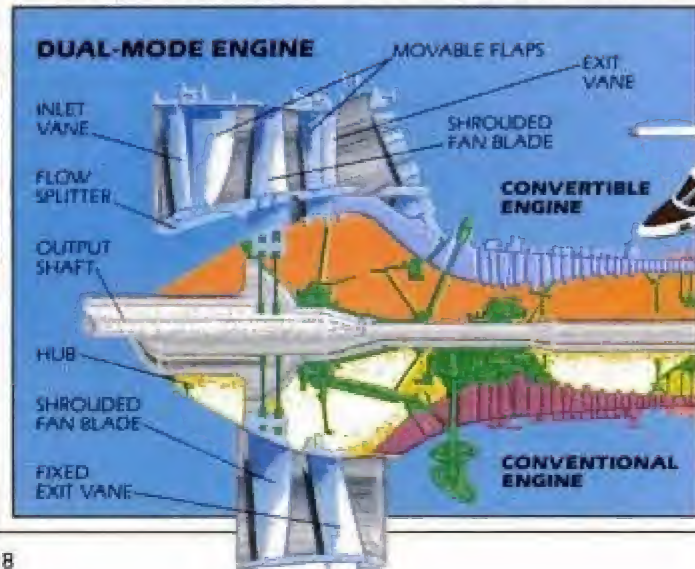
nozzle is vectored backward.

At NASA Lewis, a test program has helped develop convertible engine technology for a vertical takeoff and landing (VTOL) craft of the X-

wing type. An X-wing works like a helicopter rotor for vertical flight, then locks into a fixed-wing mode for forward flight. The challenge is to develop an engine that produces turboshaft power for the rotor during takeoff and landing, and turbofan power for forward thrust.

The convertible engine tested at NASA Lewis uses a set of variable-inlet guide vanes to switch between the turboshaft and turbofan modes.

When full shaft power is required, hydraulic actuators move rudder-like flaps on the vanes to deflect incoming airflow so the engine's fan spins freely without producing thrust. For fan thrust, the flaps straighten, and a clutch disconnects the output shaft.



Half of unmodified TF34 is shown below half of modified convertible engine (left), which might power future X-plane (above).

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Your car can have more power like that too.

What about additives that claim to be one time treatments that will last the life of an engine? Well, I've been following the scientific literature on lubrication for a very long time. As far as I know, there isn't a shred of scientific evidence for such a claim. So don't believe it!



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Several months ago, a nice man I'd never seen before walked into my office, big smile on his face, sat down and said, "Would you believe 340,000 miles on a **Tufoil** engine?" He went on to rave about how well his engine has been running all these years. I couldn't get a word in edgewise.

It made me very proud.

Recently, a truck driver called in with over 1,000,000 miles on a diesel using **TUFOIL** - Wow!

A customer from Vermont added 10% **TUFOIL** to his sticky mechanical transmission, called in and said he couldn't believe it... "Shifting is like slicing butter now!", he said.

SAAB owners are writing letters praising **TUFOIL** in their "NINES" magazine. They report spectacular improvements in their engines and transmissions!

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The U.S. government has awarded us 6 patents so far...so have Germany, England, France and Canada.

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One customer put it nicely when he said, "You can hear it...you can feel it!"

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See NASA Tech Briefs for technical details, 1986, 1987 and 1988.

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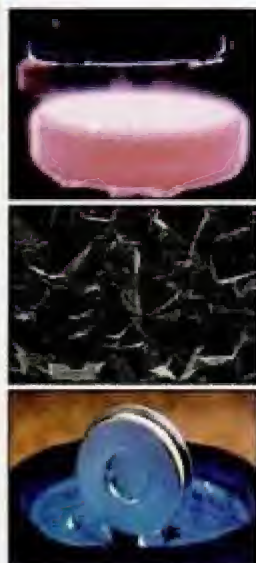
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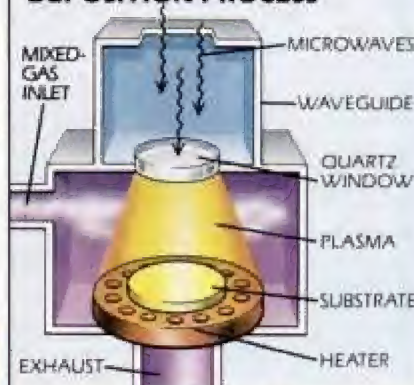
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MICROWAVE DIAMOND DEPOSITION PROCESS



Plasma deposition (top left) produces X-ray window (bottom). Micrograph (middle) shows structure. Microwave deposition (above) is another technique.

New Uses For Diamond Films

STANFORD, CA—As deposition techniques improve, inexpensive diamond films, produced with only methane and hydrogen, are finding their way into the marketplace.

Ranging from a few hundred to 10,000 atomic layers thick, the films can be deposited on a variety of surfaces, and have a number of very useful properties. Apart from extreme hardness, they offer corrosion resistance, excellent heat conductivity, and the ability to act either as one of the best electrical insulators, or as a semiconductor faster than silicon.

One of the first applications takes advantage of diamond's transparency to a wide spectrum of radiation. X-ray windows are being manufactured from the substance by Crystallume, Inc., for use in highly sensitive X-ray detectors.

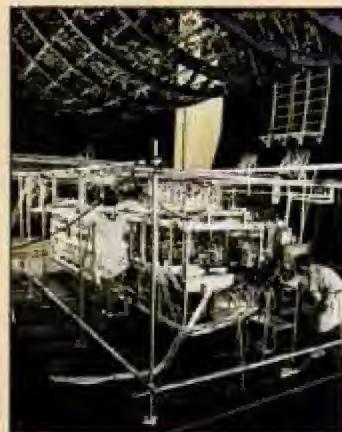
Hitachi has plans to market tool bits coated with diamond film. Other manufacturers will soon introduce tweeter elements for high-end speakers, and optical coatings.

Freedom Update: Space Station Systems Take Shape

NEW YORK, NY—Working toward the preliminary design review scheduled for late next year, NASA and contractors all over the country continue to refine the technology of living in space.

Currently at the most advanced stages of development are the environmental control, data management, photovoltaic power and thermal control systems, and a teleoperated servicing robot. Proof-of-concept hardware for the thermal control system has recently been delivered to Johnson Space Flight Center.

Built by Lockheed, the ground test unit will demonstrate technology to be used in removing excess heat from inside the Space Station.



Lockheed technicians prepare thermal control unit for test in vacuum chamber.



Heat acquisition devices inside the modules evaporate an ammonia coolant sealed inside of advanced heat pipes. In the absence of gravity, liquid and vapor are kept separate inside the pipes by control devices that rely on capillary action.

The vapor is piped to a 50 x 50-ft. radiator outside the Station, where it is condensed, and pumped back inside for reuse.

Johnson is also operating a test bed for Freedom's data management system, based on components delivered by prime contractor IBM. Controlling both Station operation and experimental instru-

ments, the system will be more thoroughly integrated with the craft than computers on earlier space vehicles. Terminals will be placed at strategic points around the Station, and ports will be provided to hookup portable terminals in other areas.

Surprisingly, the components delivered so far are not terribly exotic, based on the refined and reliable PS/2 line. The big challenge is keeping the architecture open enough to accommodate new technology expected in the 1990s.

Air bearing systems, such as the one shown below right, are used to design structures for Space Station Freedom (above). They enable engineers to simulate weightless conditions.



It's in the dictionary next to the word "flavor."

Okay, so it isn't. But it should be. Because Merit's flavor is richer and more satisfying than you'd ever expect in a light cigarette. And Merit has even less tar than other leading lights, too. Look it up.

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Americans go with the truck leader. For the past 12 years, Americans have chosen tough Ford pickups over all others.* And they're satisfied with their choice — because Ford has the highest percentage of *repeat* buyers of any full-size pickup!** Last year Ford's F-Series pickups beat Chevy again by a big margin.

BIGGER ENGINE, MORE TORQUE!

Ford's pickups offer a bigger stan-

dard Six — with 10% more torque than Chevy. V-8s range from most powerful small gas V-8 to biggest diesel in *any* pickup. Only Ford pickups offer four multiple-port electronic fuel-injected engines. When properly equipped, some Fords are rated to tow a 12,500-lb. trailer.

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Ford offers a complete range of cab choices. There's a Regular



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On many models, Ford carries more maximum payload than comparable Chevys.

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Now on Ford F-150 4x4s!

Fords also come with standard equipment the Chevy C/K doesn't. Features like halogen headlamps, AM radio with digital clock, and four gauge package.

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185-hp. 5.0L EFI V-8
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230-hp. 7.5L EFI V-8
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BUILT FORD TOUGH

OUTDOORS

BY JOE SKORUPA

This Land Is Your Land: The Battle Over PWCs

All the modern inconveniences.—Mark Twain

NEW HAMPSHIRE'S White Mountain National Forest isn't as grand as the Grand Canyon or as *bad* as the Badlands, but it's no less a magnificent treasure. Some of my most memorable wilderness experiences occurred here, especially along the 7-mile length of the Franconia Ridge Trail.

You can reach this route by taking the Liberty Spring Trail from the parking lot at Whitehouse Bridge, a few miles south of the Old Man of the Mountains at Franconia Notch.

The ascent begins with a pleasant ramble through a lush forest glen. Then it angles upward, climbing 2700 ft., for a demanding hike to the ridgeline. This is the fastest route I know to the high country, my favorite terrain, with its panoramic views and rocky trails.

The first time I hiked this ridgeback, which ultimately leads to the Mississippi-long Appalachian Trail, was with Boy Scouts, Troop 93, in 1963. It remained a favorite of mine through the next 20 years and I returned to it often, until recently.

Road not taken

In the spring of 1985 I went back to the Whitehouse Bridge and found bulldozers hard at work. A 20-mile stretch of Interstate 93,



PHOTO BY RON THOMAS/PPG

Is there a place for jet-powered personal watercraft on this lake, or should it be off-limits?

which runs from Boston to the Vermont border, was in the process of being carved out of my personal Eden.

The construction crew wasn't actually demolishing the trailhead, just doing plastic surgery. But when it was completed, my love affair with the Franconia Ridge Trail was over.

Instead of 360° panoramas, my paradise was cut in half: marvelous beauty to the east and a 3-lane (northern portion) or 4-lane (southern portion) scar to the west. Even worse was the incessant

whoosh of traffic. Although the expanded highway is a few miles away and thousands of feet below, the noise of speeding vehicles is ceaseless and all too clear—no overhanging trees dampen it, no serendipitous turns slow it down.

This memory came to mind soon after publication of my apparently incendiary column, "Invasion Of The Water Snatchers." (See page 39, April '89.) The flood of letters from readers this column inspired was surprising, but even more amazing was they all disagreed with my opinion that personal watercraft (PWCs) are unfairly targeted by legislators, most notably in New Hampshire.

Most of the letters were thoughtful and illuminating. Many, however, were filled with invective. And a few, not necessarily the coolest heads around, suggested my immediate dismissal, blacklisting and, in one case, a "firing squad."

Don't look back

When Interstate 93, with its modern bulk and loud voice, transformed my beloved ridgeback into an adjunct of the highway system, I was angry, I was mad. I was peeved. But ultimately, and inevitably, I adjusted to the situation by moving on. My hiking buddies and I explored new areas and discovered

(Please turn to page 28)



Loss of breeding habitat threatens the loon.

PHOTO BY STAN OSKOWSKI/PPG

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OUTDOORS

(Continued from page 24)

ered new ridgebacks. Naturally, I'll always miss the special pleasures of Franconia Ridge, but I'll learn to live with it.

I'm not so sure people are ready to live with PWCs, which are obviously a red-hot issue right now, a *cause celebre*, something that divergent groups of people love to hate. Property owners and conservationists, boaters and fishermen, and lobbyists and politicians are all up in arms over a water toy they call ski craft, thrill craft or, mistaking the trees for the forest, Jet Skis. (Personal watercraft, the most appropriate name, is rejected as an innocuous-sounding euphemism, according to one reader, "akin to calling drug dealers pharmaceutical distributors.")

While I don't retract or modify my earlier position, I believe certain points, apparently open to misinterpretation, should be made crystal clear:

1. Here at POPULAR MECHANICS, we strongly advocate *responsible* PWC operation. This not only means following all boating rules of the road, but observing common courtesy.
2. We strongly support all conservation efforts designed to protect threatened and endangered species, especially the

loon, which nests in shallow water.

3. All facts stated in my "Invasion Of The Water Snatchers" column are accurate. More than one reader alleged misrepresentation, bias, inaccuracy. I've since double-checked all points in question (too many to list here) and I stand by my story.

4. Neither I, nor anyone at PM, will ever write a story to placate advertisers. It has never happened in the past, and it will never happen in the future. This iron-clad rule goes for large advertisers and small ones, of which PWCs are among the smallest of the small.

Shock of the new

Nothing so needs reforming as other people's habits.—Mark Twain

The inspiration of my "Invasion Of The Water Snatchers" column was last year's banning of PWCs on bodies of water less than 75 acres and on 15 larger lakes in New Hampshire. Legislative action in other states and communities was also cited, raising the fear that PWCs would soon be severely restricted nationwide.

Thanks to all the letters and my follow-up phone calls, I've since become well-educated on the PWC controversy, especially in New Hampshire. There are currently 50 bills pertaining to PWCs pending in the Granite State.

The one most likely to emerge is a bill allowing citizens to petition for PWC restrictions on a lake-by-lake basis. Last year's ban, on smaller lakes and 15 larger exceptions, remains in effect.

Interestingly, the compromise bill's original language was just the reverse—banning PWC use first and then permitting lake-by-lake hearings later. Current Governor, Judd Gregg, by the way, is on record as opposing PWC use entirely. (Reportedly, he joked about "taking a sledgehammer to them.") And former Governor, Mel Thomson, is in favor of the Draconian language of the original bill.

Even staunch opponents estimate that only 1500 to 2000 PWCs operate in New Hampshire, so why all the fuss? Why the invective, the flood of restrictive bills, the record-breaking attendance at hearings?

Human nature is at work here. PWCs are new and radically different from traditional water sports. Adjustments to noise and close-to-shore usage are required by nonusers. PWC riders, in general, are youthful and prone to hot-dogging and abuses, no doubt, have occurred. And finally, water resources are limited and fast approaching critical overuse, which is the real reason loons have diminished. PWCs are the new kid on the block and an easy scapegoat for

home from top to bottom.



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present ills. (On the phone, several readers admitted that PWC laws are the first shot in their war for more restrictive lake management policies, and that canoes and kayaks are even more troublesome to nesting loons than PWCs.)

Where do you stand?

I don't know about you, but to me PWCs are a lot easier to live with than depletion of the ozone layer, global warming, acid rain, ocean dumping, oil spills and toxic waste sites. Is the PWC controversy really more emotionally charged than, say, the rapid extinction of species, estimated in a recent issue of *National Geographic* to be about one million losses in the next 25 years, or one every 15 minutes?

The only way I can explain it is that people are fed up with the continuing erosion of what used to be called quality of life. They want to fight, even if only symbolically, for a comfortable lifestyle that's rapidly disappearing. And they've targeted PWCs as another outlet for their growing urge to declare, "Not in my backyard!"

I believe the PWC controversy raises a number of questions. Is there a place for safe, responsible use of PWCs on our waterways? Do PWC users have legitimate rights? Are lakes and rivers be-

coming dangerously overcrowded? Is continued survival of wildlife incompatible with current heavy recreational use of resources? And, finally, is opposition to PWCs really just a symptom of a larger problem that should be the real focus of our attention?

I'd be interested to hear from readers concerning your responses to the above. Ultimately, I believe the world will adjust to PWCs, just as it did to the railroad, horseless carriage and motorboat. (Just as I did to the work on Interstate 93.)

But in the meantime, PWC devotees, of which I am one, must police their ranks. There is a perception among the general public, recently fueled by network television reports with film footage to support it, that PWCs are regularly driven in an inconsiderate and dangerous manner. This perception, I've recently come to understand, operates on two levels: 1. Many nonusers genuinely believe that the average PWC rider is a born troublemaker (or worse), who is attracted to PWCs because 2. PWCs, by their very design, are reckless (or worse) vehicles.

The craft may be intimidating to nonusers, and even annoying, but like all plastic-and-metal machines, they're inherently neutral. (I'm excluding weapons of destruction.) When used

responsibly, I've no doubt that PWCs are as capable of following the boating rules of the road as any other craft on the water.

What are some of the worst PWC offenses? Here's a short list: 1. Wake jumping, 2. Driving out nonusers from an area by monopolizing it, 3. Running too close to shore, 4. Running too near swimmers, 5. Making noise too early in the morning, 6. Not yielding right of way to other boats, 7. Chasing birds and other wildlife, and 8. Disobeying no-wake signs.

None of these is a capital offense, but taken together they add up to a pattern of abuse. This is, perhaps, the most damning criticism of all, because it seems to point to the necessity of increasing marine patrols at a time when there is no money available to do so.

To be honest, I spend roughly 600 hours on the water each year in various parts of the country and I've never witnessed an outrageous PWC incident. Maybe I've been lucky, but I don't think so. Nevertheless, I still think it's up to PWC users to police themselves and the time to start is now. The future of the sport is in their hands. The best advice I can give, which comes from a born troublemaker himself, Mark Twain, is: "Always do right. This will gratify some people and astonish the rest." **PM**

INSIDE DETROIT

BY JIM DUNNE

Focusing On The 1992 Bonneville

THE FURTHER our camera looks into the future, the fuzzier the picture becomes. This prototype of the 1992 Pontiac Bonneville is undergoing tests now at GM's proving grounds in Michigan and Arizona.

Much of the rear part of this car is disguised to hide the C-post area. The sloping panel at the rear covers an upright back window, and distorts the appearance of the car, this to cover Pontiac's actual styling intentions.

But the front end is another story. Because the car's new styling may affect the air intakes used for engine cooling, no disguises are permitted. So the front end shown in this spy photo is just about what the 1992 Bonneville will look like.

Mechanical details are unchanged for the most part, with front-wheel drive and 3.8-liter V6 engine similar in most respects to today's Pontiac flagship model.

Probe, 1990

An all-new model just over a year ago, the Probe for 1990 will be only slightly changed in appearance. Look to the grille texture to see the difference. An eggcrate insert in the grille opening identifies the '90 model. The '89s have open scoops with no grille.



Ford Probe for 1990 will get minor revisions to grillework.



Though heavily disguised, 1992 Bonneville test mule indicates what front of Pontiac will look like.

Probe will continue with a 4-cylinder engine until the 1992 model is introduced. At that point a Ford-made V6 will become the top engine option.

Probe is manufactured as a joint Ford-Mazda venture at the new Mazda Flat Rock plant, just outside Detroit.

Caprice Comments

A sample drive of the 1991 Chevrolet Caprice shows that the car is little different in acceleration and handling from current models. But the big Chevy sedan of the future is dramatically different in appearance and modestly improved in ride.

Its exterior styling changes speak for themselves. The new car is 3 in. wider and 2.5 in. longer than

the 1989 Caprice. It appears even bigger, with its softly curved body surfaces and aero profile.

The windshield angle is particularly interesting. The base of the glass will be moved forward about 6 in., giving the glass an aggres-

sive rake. Because of this one change, the wipers will be exposed, rather than hidden under the lip of the hood.

Also, the heater/air-conditioning system will be moved from under the hood to the interior of the car, under the instrument panel.

tons and rocker switches, the Caprice radio will use twist knobs for ON/OFF, VOLUME and station tuning.

"You won't see a POWER button either," reports our Chevy engineer. "It's just not necessary."

While the skin is new, the



1991 Chevy Caprice will ride atop current rear-drive platform.

However, the ride has been improved through the use of softer body insulators, designed to soak up some of the harshness of the tires, producing quieter, smoother operation.

Caprice's 1991 basic layout is tried and true. It uses a 5.0-liter fuel-injected V8, 4-speed automatic, and rear-wheel drive, all mounted in a frame-and-body chassis. That's a virtual carryover from the 1989 model.

However, the ride has been improved through the use of softer body insulators, designed to soak up some of the harshness of the tires, producing quieter, smoother operation.

Radio controls are also "new." In place of pushbut-

Placebo Pedal
A dummy clutch pedal to go along with its new type of

Placebo Pedal

A dummy clutch pedal to go along with its new type of

(Please turn to page 32)

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What's The Right Oil For Your Light Truck?

I've received a lot of letters recently from owners of light trucks, which include popular mini and mid-size sport pick-up trucks.

And their #1 concern is motor oil. What's the best oil? Can I use the same oil for my truck that I use in my car? Are there motor oils exclusively for light trucks? The answers fall into three categories.

Truck Engines Vs. Car Engines

First of all, the main thing I want to stress is that there's *no difference* between light truck engines and passenger car engines.

It's not *what* you're driving, but *how* you're driving your light truck that makes the big difference. Like using it for off-road in 4-wheel drive. Pulling big trailers. Hauling heavy loads. The kind of driving that makes your light truck engine rev higher, run hotter, and work harder than your car engine.

And with this kind of rugged driving, more frequent oil changes are needed, to avoid oil contamination and the possibility of severe engine wear.

Finding The Right Oil

To be sure you're using the proper motor oil, you should follow one simple rule: *Check your owner's manual.* It'll tell you the *exact* weight and API (American Petroleum Institute) classification your light truck is



By Don Johnson

*Vice President, Product Engineering
Pennzoil Products Company*

designed to use. By following your manufacturer's recommendations, you're assured of getting the best protection for your truck engine, and your truck warranty. Don't choose a motor oil based on price or convenience. *If it's not the right weight and API classification recommended in your owner's manual, don't use it!*

The Myth Of "Specialty" Truck Oils

Some of you have also asked me about certain oils claiming to be "specially-formulated" for light trucks. These so-called "truck" oils have an API classification of "CE"—a classification for heavy-duty trucks, like 18-wheelers with Cummins or Mack diesel engines.

You won't find these oils recommended in your owner's manual for

gasoline engines. So for *all* gasoline powered light trucks, a classification of "SG/CD" is strongly recommended.

The important thing to keep in mind is, even while an oil may not be harmful to your engine, if it's *not recommended* by the manufacturer, and you have an oil-related engine problem, your truck warranty could be voided, and repair costs could be yours alone!

My Recommendation

For light truck owners who want the best in engine protection, I tell them to check their owner's manual. And then, choose quality Pennzoil in the weight recommended by the manufacturer.

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about your motor oils, lubricants and engines. However, you can tell us a few things, too. Maybe you've discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Don Johnson, Pennzoil Products Company, P.O. Box 2967, Houston, TX 77252-2967.



World Class Protection™

manual transmission is one of the suggestions the Luk company is hearing from the auto companies. Luk, a German company operating out of Ohio, supplies clutches and clutch parts to all of the U.S. automakers. Their latest design is an automatic/manual transmission that needs no clutch pedal. Just move the shift handle, and a clutch automatically disengages through a torque converter. In addition, the Luk clutch helps a car run smoother. The torque converter dampens the vibrations that come from engine pulses or torque spikes and driver error.

But when Luk engineers demonstrated the new system for Detroit's engineers, they were asked if they could put the clutch pedal back in the car. Many drivers want a clutch pedal, it seems, whether they use it or not. So Luk is now investigating a clutch system that uses both a manually operated clutch and an automatic. Or, as has been suggested, a setup with a dummy pedal.

Preheater

Summer may be the wrong season to talk about it, but GM is developing a heater system that will warm up your

car before you start it in the morning. A small gasoline heater is designed to ignite—either by remote control or automatically—and heat up the engine coolant.

An extra water pump and the car's heater system is used as part of the heatup sequence. After a half hour or so, the engine becomes warmed up, the interior of the car reaches about 55°, and the windshield is cleared of frost.

The system reportedly is similar to one sold in Europe.

GM Alphabetic

Oldsmobile ran into unexpected difficulty in assigning a code letter to one of its future models. Originally, the vehicle was assigned the letter Q as part of its code name. But that was soon switched to the letter G.

It seems that not all the computers at General Motors read the letter Q in quite the same way. To some of the computers, it meant something else that had nothing to do with automobiles. So the encoders went back to the code room and punched up another of the General's much-used G codes.

Saturn-San

If you can't lick 'em, copy them. That seems the plan at Saturn, where Japanese methods, machines and marques are used to help produce the new subcompact due out in the fall of 1990.

The Japanese work method of cooperation between worker and management is in full bloom at Saturn. Union members work alongside management in everyday chores as well as in strategic planning meetings. A number of heavy-duty Japanese machines are installed in the Saturn plant, including two monster 4500-ton stamping presses that bear the Komatsu brand and smaller Hitachi-Zosen presses—all imported from Japan.

All-American Mazdas

Mazda officials say their assembly plant in Michigan builds MX-6s to the same high-quality levels as those built in Japan, and perhaps even higher.

It is generally accepted that Japanese quality has been the standard of the world lately, so the Mazda estimate is highly significant.

Much of the credit is given to the U.S. auto workers, who accept the Mazda plan for more cooperation between workers and management.

The Mazda system of continuous improvement—*kaizen*—is working in the U.S. plant. Teams of workers identify a problem, plan together to get it fixed. It is also pointed out the Mazda plant in the U.S. has the benefit of operating with all new machinery—dies, presses, machine tools—and the latest in electronic controls.

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OLD HOUSE RESTORATION

BY BOB VILA

Restoring Slate And Tile Roofs

IF YOUR old house has an original slate or tile roof, consider it a lucky inheritance. Aesthetics aside, many of these early roofing materials are still functioning well today, after years of exposure to time and the elements.

But when roofing problems arise in one of these original relics, it's often time for the lucky old-house owner to stand firm against the advice given by many modern roofers to replace these beautiful, old materials with today's asphalt shingles.

In most cases, whatever problems do arise after years of faithful service can be repaired. If you're a sophisticated do-it-yourselfer—and aren't afraid of heights—you can probably tackle many of these repairs yourself. If not, it's simply a matter of doing some research to find a qualified roofer who has experience restoring slate or tile roofs, and is sensitive to your desire to save it.

Let's take a look at these historic roofing materials and the problems that are likely to arise with them, as well as the best way to complete your restoration.

The basics

Longevity, coupled with the fact that they are virtually maintenance-free, are two of the prime advantages of slate and tile roofs.

Considered the finest roofing material money can buy, slate was popular until the late 1920s. A naturally durable stone, it's not uncommon for a properly laid slate roof to last 100 years or more.

Slate will differ in color depending on the veins from which it was mined, and gen-



NEW ENGLAND SLATE CO. PHOTO

Slate, clay and concrete tiles are all great roofing materials. Their longevity and durability are well-known in the building business as is their beautiful appearance, shown in this old slate roof.

erally ranges from various shades of blacks, blues, grays and greens to the rarer purples and reds.

There are two kinds of tile roofs: clay and concrete. Commonly associated with Spanish Mission, Romanesque Revival and Italian Villa-style houses, clay tiles have been produced in America since the mid 1600s. Found in numerous configurations, most common are either flat or Spanish S-shaped tiles.

Concrete tiles, manufactured in the early 1900s, were very popular then. Predominantly red or green, time and the elements have often eroded most of the color from the exposed portions of these tiles. So what you often see, when you look up at an old concrete tile roof, is something akin to a giant sidewalk. Like clay tiles, both S-shaped and flat concrete tiles are commonly

found on old-house roofs. Some of the latter, called bar tiles, have channels, flutes or ribs on the top surface.

All these materials are still being manufactured or quarried—in the case of slate—today. As a testament to their longevity, it's not uncommon to find a 50-year warranty with these new products. Of course, quality like this doesn't come cheap. You can expect to pay many times more for a new slate or tile roof than you would for even the best asphalt material money can buy.

But unless the elements have totally deteriorated your old roofing material, repairing your roof shouldn't mean a total replacement. It is possible, in many cases, to restore an existing slate or tile roof.

Reasons for failure

One of the biggest culprits in slate roof failure is initial use

of the wrong nails. Copper nails are the only thing that should ever be used to secure this material. If you notice an alarming number of slates are loose or missing, the reason could be that the old nails—which were probably iron—have deteriorated. The worst case scenario is that the whole roof was laid this way. If deteriorated nails is the case, the only solution may be to take up the remaining slates and re-lay the roof correctly.

Occasionally, the slate itself will be at fault. Some slates are naturally more porous than others and, over the years, the natural freeze-thaw cycle will take its toll on them. The results, spalled or delaminated materials, weaken the roof as a whole and must be replaced.

Another problem common to both slate and tile roofs is breakage from mechanical means. Usually, this is the

Contributing Editor Bob Vila is host of public television's "This Old House."

result of fallen tree limbs or walking on the roof—perhaps to install a TV antenna—and stepping on the roof the wrong way. You really have to be careful on these surfaces to distribute your weight evenly by walking on the areas where the tiles or slates lap one another—this, of course, is the strongest spot.

Since any cracked or missing tiles or slates leave dangerous gaps in the surface for the weather to enter, locating these weak spots is your first defense against future leakage and rot.

Replacing slate and tile

If you've caught the problem in time and the felt paper, which acts as a vapor barrier under the roof, is still functioning properly—meaning it's repelling water—individual tile or slate replacement is usually all that's required to get that old roof back in shape.

The easiest tiles to replace are those that have lugs on the back which simply latch over the wood strip. Once the broken tile is removed, a little shove with your hand is usually all that's needed to make the new tile jump over the strip. In addition to the hold of these back lugs, the tile is also interlocked with its neighbors on both sides and overhead. Depending on the roof's pitch, this is usually sufficient for it to stay in place.

Many times, flat or S-shaped tiles are nailed at the top to the wood strip. If you can't get up that far to nail in a new tile, inserting and nailing a copper strip between the tiles can act as a clip to hold the replacement piece in place. Simply push the new tile up and in place, then bend the copper strip up to hold it.

Replacing slate is a similar process. Using a ripper, a special tool designed for this type of roof work, release the old slate and clear the pocket of all old nails. Then simply slide the replacement slate in place, securing it with a slate hook. These galvanized, heavy-gauge wires are formed into a small S-shape. A nail in the top part of the hook secures it to the roof, while the bend in the bottom holds the slate in place.

Probably the most difficult part of this project is finding the needed replacement pieces. The color of both tiles and slate will always vary. Add to this the altering effects of the elements and pollution, and you can see that finding the right match may take some digging.

Because of this, it's best to first try to find replacement materials locally. If you've got a tile or slate roof, yours probably wasn't the only one laid in your community. Others have probably been removed and replaced with more modern roofing materials over the years. Check the Yellow Pages for the oldest roofing company in your area. Chances are, they may have an inventory of the old materials they've removed.



NEW ENGLAND SLATE CO. PHOTO

Slate tiles not only vary in color, but also in size and texture. Clay tiles, on the other hand, can vary in color but are much more uniform in size and texture. Concrete tiles are the most uniform of all.

If your local search fails, there are companies that inventory this type of thing. Raleigh, Inc., 1921 Genoa Rd., Belvidere, IL 61008, (815) 544-4141, will ship replacement tiles and slates anywhere in the country. The New England Slate Co., Burr Pond Rd., Sudbury, VT 05733, (802) 247-8809, is another good source for salvaged slate.

Take up and re-lay

Unfortunately, roof restoration problems often go a bit deeper than just simple replacement. While the majority of these roofing materials will successfully withstand the test of time, the underlayment will not.

If the felt paper is dry, parched or cracked so that it no longer repels moisture or sheds water, then you've got a bigger job on your hands. Many times when the felt paper has failed, you'll find that the wood strips, or battens, the tiles are attached to have also deteriorated. Even more serious is the probability that the decking below has also begun to feel the effects of the weather and it, too, has started to rot.

If that's the case, you'll have to *take up and re-lay* the roof in these problem spots. Basically, this involves removing the tiles or slate, replacing the decking, wood strips and felt paper, then laying the original tile or slate back down.

Deterioration like this usually occurs in places where moisture tends to accumulate, like eave courses and areas near dormers and valleys, or in spots where the freeze-thaw cycle or ice damming occurs. Of course, any places where you've had broken or missing tiles or slates for a prolonged length of time or where the flashing is worn and ineffective are also prime candidates for structural damage underneath.

If you discover that your roof does warrant this work, your experience and expertise level—as well as the pitch of the roof—should be a guide when deciding whether or not you can do this job yourself. If you decide to go the professional route, make sure the contractor you choose has good references. **PM**

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ELECTRONICS

BY STEPHEN A. BOOTH

The Reruns Of August

NOTHING IS supposed to happen in August. This is why it is nicknamed "the dog days." To seamen of the sailing age, the winds died and becalmed their ships in the month when Sirius, the Dog Star, rose and set with the Sun. To people of the television age, August is reruns time, the dark before the dawn of a new programming season.

Contrary to its lethargic reputation, August can boast lots of memorable broadcasting events. On Aug. 5, 1921, radio station KDKA in Pittsburgh delivered the first broadcast of a major league baseball game. The dog days brought the first major league telecasts, too—in black and white on Aug. 26, 1939, and in color on Aug. 11, 1951. Both came from Ebbets Field, courtesy of the Brooklyn Dodgers and NBC.

Actually, the first baseball telecast (and first sports telecast of any kind) hit the airwaves on May 17, 1939—

exactly 50 years to the day this column hits the press. It was NBC's camera again, at a game between Princeton and Columbia, alma mater of Yankee great Lou Gehrig.

Just 17 days before, on April 30, NBC had begun regular telecasts with the first airing of a presidential address—Franklin Delano Roosevelt opening the New York World's Fair. Because fewer than 200 TVs were available, only about 1000 people saw FDR compared to some 24,000 who turned out at Yankee Stadium that day. The people who witnessed the first presidential telecast probably didn't realize it would change politics forever, any more than the baseball crowd realized it was witnessing Lou Gehrig's last game.

As noted in last month's column ("Electronics," page 20), regular telecasting in the U.S. commenced 50 years

ago at the New York World's Fair. But TV wasn't born in 1939, nor is it the brainchild of any one inventor.

The precedents reach back to the late 19th century, and represent the contributions of many individuals. This heritage is elaborately documented in the exhibition of TV's history, titled "American Television From The Fair To The Family, 1939-1989," currently running at the Smithsonian Institute's National Museum of American History.

You'll find the exhibit in the museum's Nation of Nations wing—an appropriate location, as TV was an international development. In fact, the term *television* was coined by a Russian, Constantin Perskyi, presenting a technical paper in Paris in 1900—though American science-fiction maven Hugo Gernsback popularized the word. Earlier, in 1879, Brit-

ain's Sir William Crookes had begun experiments with the cathode rays needed for electronic television, and by 1897, Germany's Karl Ferdinand Braun managed to control the electron scanning beam in a cathode-ray tube.

While work on electronic television progressed in the wings, the public's first acquaintance with "radio-movies" came with mechanical television.

In 1884, Germany's Paul Gottlieb Nipkow developed a mechanical scanning device that could transmit images over short distances. The basic idea was to direct the light reflecting off a subject through holes in a spinning disc—much like the shutter of a motion picture camera. But instead of directing the exposures to light-sensitive film, the image receptor was a photoelectric cell.

Mechanical TV broadcasts commenced in the 1920s. Britain's John Logie Baird

(Please turn to page 38)

Below, Pilot 3-in. TV with mineral oil magnifier (top) and Zenith porthole set.



Philco's Predicta (below) was futuristic compared to the conventional Admiral console (left).



Vintage shows include (from top left): "Howdy Doody," "I Love Lucy," Brooklyn Dodgers from Ebbets Field, Gleason's "Honey Mooners."



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ELECTRONICS (Continued from page 36)

introduced a working system in 1925, a development paralleled in the U.S. by Charles Francis Perkins. The latter, a lone inventor who also developed the modern movie projector, became a broadcaster in 1928 when the federal government issued permits for experimental telecasts. His two experimental stations aired movie films, which Americans could view through the 1-in. peepholes of homebuilt, spinning-disc receivers. Soon after, the big boys like RCA (NBC) and General Electric jumped in.

Developments in all-electronic TV would short-circuit the mechanical system. Between 1923 and 1931, all the pieces were in place, thanks to simultaneous breakthroughs in display and camera tubes by Philo T. Farnsworth, a Midwestern whiz-kid, and RCA's Russian-born Vladimir K. Zworkin (the independent David and the corporate Goliath would fight patent battles for years to come). Ironically, the British Broadcasting Corp. embraced the boob tube in 1936—three years before NBC's World's Fair telecast and five years before the U.S. Federal Communications Commission okayed our present NTSC (National Television System Committee) method of telecasting.

The rest is history. Although NBC began regular telecasts in 1939, and TVs were on the market (pioneer Allen B. DuMont was actually selling a "giant" 14-in. tube receiver in 1938), TV didn't take off until after World War II. Some 6000 receivers were produced and sold in 1946, with nine stations on the air—including the now-defunct DuMont network, where the late Jackie Gleason and his "Honeymooners" made their 1955 debut as a skit on the original "Jackie Gleason Show."

By 1950, 140 brands were producing more than 5 million sets a year. The golden age of TV was in full swing with classic programs such as "The Milton Berle Show" (1948) and "I Love Lucy" (1951) appearing in glorious—and live—black and white. Color TVs and videotape wouldn't become available until 1956.

This year, Americans will buy nearly 10 million VCRs and 22 million TVs—most of them color. There is a TV in virtually every home, and a VCR in three out of every five. Meanwhile, just over the horizon is wide-screen High Definition TV, possibly in time for the 1992 Olympics.

Smart Money

Magnetic technology is used for much more than recording TV programs on tape. The U.S. government and other money-making entities embed magnetic particles in their currency, so they can tell the real thing from counterfeit.



Counterfeit cash is a billion-dollar a year business. Cashscan (above) and Vistatector examine bills for the magnetic printing embedded in genuine currency.



Apparently, there's a lot of bogus cash in circulation—the U.S. Secret Service estimates that more than a billion dollars worth of phony greenbacks hits the streets each year. To help small businesses avoid getting stuck, two companies have introduced countertop counter-counterfeit devices.

Vistatector (\$100) by Vistatech Enterprises and Cashscan (\$150) by a company of the same name each examine the portrait side of a bill for the correct placement and intensity of the magnetic imprints, and flash the pass or fail sign in about a second. On U.S. currency, the lettering of the bill's denomination below the portrait is magnetized—but the devices go a step further by checking for magnetism where it *isn't* supposed to be.

Phony Tape

Speaking of counterfeits, there's plenty of unlicensed videotape around. If a VHS cassette lacks the VHS trademark logo, this means it hasn't been approved by JVC, the licensor, and might be substandard in quality. Besides the tapes that don't carry the VHS logo, there are off-brands that use the logo without authorization from JVC.

With hundreds of brands on the market, it's tough for JVC to police the U.S. market from Japan. So we're happy to learn that JVC has designated the Advanced Product Evaluation Laboratory—the same lab that performs our electronics tests—to conduct enforcement testing here. In our opinion, JVC couldn't have picked a finer lab. **PM**

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Motor Trend Truck of the Year Award 1989. © 1989 Toyota Motor Sales, U.S.A., Inc.

BY TIM COLE

How We're Destroying The Canadian Wilderness

DEVELOPING ways to preserve Earth's fragile environment is one of the most compelling science issues of our time. But when the discussion turns to acid rain, the issue also gets political. Nowhere do the competing interests of environmentalists, industrialists and politicians clash so directly. Careful scientific analysis by the U.S. and Canadian governments has helped focus attention on the problem—but adequate solutions that reduce sulfur-dioxide emissions from aging coal-fired generating plants are still a distant goal.

Focus on the future

The accompanying charts reveal the source of most SO₂ emissions that ultimately fall on pristine Canadian lakes. Electric plants in America's central states are producing tons of SO₂ annually. Prevailing westerlies transport the acid to the more than 300,000 lakes and streams in the eastern provinces of Canada—all prime fishing grounds and hatcheries. It's estimated that 14,000 lakes in Canada are completely acidified—with the loss of all indigenous fish species. Acid rain is also damaging U.S. lakes, according to EPA estimates, including 3800 in the Northeast. Lakes aren't the only casualties. Forest dieback is accelerating, which affects logging and maple syrup industries, as well as tourism. Corrosion in the infrastructure has affected buildings, monuments and bridges.

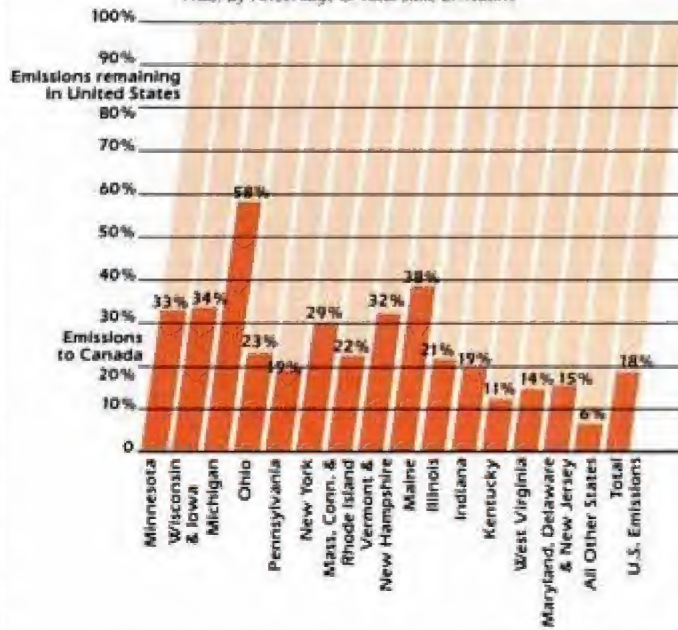
Computer models and field experiments show that transborder movements of sulfur dioxide were on the order of 3.2 million tons in 1985, with projections of between 3.5 million and 4.2 million by 1995. Ninety percent of the flow originates within 300



The slow destruction of North America's once-pristine lakes and rivers begins with sulfur-dioxide emissions at coal-fired electric-generating plants in our central states.

STATE EMISSIONS TO CANADA

1980, By Percentage of Total State Emissions



Source: Environment Canada

We're generating significant SO₂ emissions in our most industrialized states that eventually fall on American waterways—but much of what the states emit also falls on Canada.

miles of the border. Studies show that, by state, Michigan is the worst culprit, with Maine, Minnesota and Wisconsin not far behind. While 75 percent of the acid that falls on Canada originates in the States, only 15 percent of the acid that falls on our northeastern states is said to originate in Canada.

Some solutions

Recent treaties have approached the problem cautiously. Our overdependence on coal—a sad reality until this country invests in clean-coal technologies like liquefied bed combustion, and safer storage for nuclear fuel wastes—is literally killing planet Earth. Until strict SO₂ limits are imposed, however, it will take another scientific discipline—namely economics—to bring real reductions in acid rain.

The Bush Administration is promoting legislation that would allow companies to buy and sell the rights to pollute, allowing the marketplace, guided by appropriate legislation, to gradually impose measures to self-limit emissions. It's thought that pollution is an inevitable consequence of an industrialized economy, but some companies pollute more than others. By establishing an upper limit on pollution—by deciding how much is too much—and then letting the private sector sort out who will be permitted to emit SO₂—buying and selling pollution rights, for instance—real controls can be established for the first time. From then on, the total permissible tonnage of emissions from any given region can be reduced gradually as cleaner technologies come on line. Only then will we become better neighbors.

(Please turn to page 42)

Save Gas, Save Engine with 'POLY'

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The following introduces one of the most fully tested and proven gas saving, friction-reducing engine treatments ever to reach the market!

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Years of Testing and Use Have Proved it True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road:

The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

TUV, a German testing laboratory with credentials every bit as prestigious as our Underwriters Laboratories, tested Slick 50 in 1986. They found substantial increases in both gas mileage and horsepower. Their tests showed that these gains were due to a reduction in friction.

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). This FAA endurance test simulated 1400 hours of engine use.

The power technology laboratory at a leading southwestern university stated, "Slick 50 does increase horsepower and decrease fuel consumption in tests done at the university."

The Space Shuttle Columbia uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture test overseen by the Automotive Services Council for Pennsylvania and shown on WTVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.



It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "Poly" between the parts where it is burnished into the pores of the metal.

Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

Works with Most Oils

Slick 50 will work with all petroleum-based oils and all synthetics compatible with petroleum-based oils with the exception of graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
2. Increase horsepower (small economy cars and large RV's really need this)
3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine.
4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

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SCIENCE

(Continued from page 40)

Grouper Grope

One way to ensure Earth's survival is to learn more about our various marine resources. Some are renewable. Some are not. The key issue facing scientists is to learn more about a particular species' habitat in order to protect it from external influences.

John Fine, a frequent PM contributor and author of the book *Oceans In Peril*, recently returned from an expedition to study the unusual way groupers propagate. Diving about 8 miles north and east of Posada del Sol near the Honduran island of Guanaja, Fine and his team observed thousands of Nassau groupers, *Epinephelus striatus*, hanging together in a ball or cone formation between 50 and 120 ft. The groupers were mating in a rarely observed ritual.

The fish are territorial and solitary, usually living out their lives on reefs or in caves. But once each year—after the full Moon in January—they congregate near reefs around Posada del Sol. How the fish find their way to these banks at this time of year can only be partially explained by the fact that the full Moon follows the shortest day of the year. While the Moon phase may trigger migration and aid in navigation to the offshore

banks, something more is needed to guide these fish to the same site year after year.

The answer to the mystery may have been partially solved when divers observed an underwater current that swept northeast prior to and during the full Moon and for a few days thereafter. As the full Moon waned, the underwater



John Fine (third from right) and team measure grouper caught during mating ritual.

current changed direction, moving toward the Southwest.

A week after the full Moon, the groupers were gone. Just where they come from is unknown, although scientists speculate that the fish came to the mating spot from the entire reef areas on Guanaja and Honduras's adjoining Bay Islands. Part of the yet unsolved mys-

tery is how they are able to find their way over large distances while swimming underwater.

Synthetic People

The process of rebuilding human beings using biomechanical body parts continues to hold promise for shattered lives. One dilemma: Scientists have been unable to create artificial tissue to replace arteries, ligaments and other softer organs. Rejection is one problem. A lack of necessary elasticity is the other.

But now, researchers at the University of Alabama at Birmingham have developed a new bioelastic material out of polypeptides—repeating strings of amino acids—that mimic human tissue. The new material is modeled after elastin, the elastic component of blood vessels and connective tissue. It can be used to prevent internal scar tissue, a complication of most abdominal and reproductive surgery, and its ability to expand and contract makes it ideal to replace natural blood vessels, making it a superb substitute for the grafted vessels used in heart bypass operations.

Eventually, according to Dan W. Urry, director of UAB's laboratory of molecular biophysics, these bioelastic materials can be used as a scaffolding while the body's own repair systems work to replace a blood vessel. **PM**

CAR CLINIC

BY MIKE ALLEN

Ping-Pong

FOR THE last 25,000 miles or so of its 116,000 miles, my '78 Cutlass has pinged under light-throttle acceleration. If I push the gas pedal down far enough, it's not a problem, and once I'm up to speed, it goes away. The EGR valve seems to be free, and the rest of the car seems to be in proper tune. Should I start looking into the carb or distributor? STEVE WINTERS
LAKELAND, FL

Other possibilities do include the carb or distributor, but from the symptoms you describe, I'd look at the EGR system. You say the EGR valve is working. How do you know this? Have you actually had it off to look at it?

Just because the EGR valve moves doesn't mean it's recirculating sufficient exhaust gas to reduce combustion chamber temps enough to prevent ping.

Pull off the EGR valve and examine it for carbon buildup that may be choking off gas flow. Be sure the pipe that carries exhaust gases to the valve isn't plugged. After 116,000 miles, I wouldn't be surprised if most of the flow were restricted.

Try teeing a vacuum gauge into the EGR's control line, and monitoring it while the car is being driven—either use a helper, or tape the gauge to the windshield in a convenient place—to see if the valve is getting the proper vacuum signals.

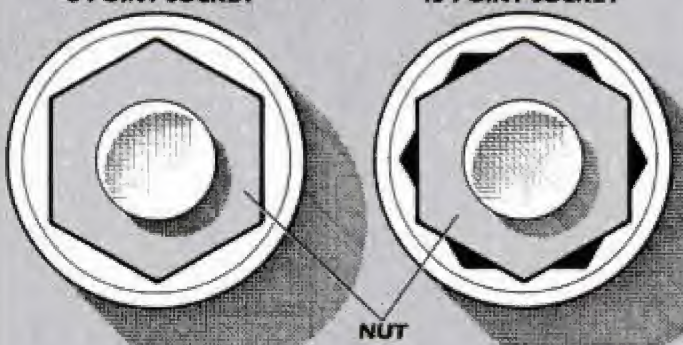
Duodecimal Thinking

You're trying to remove a really stubborn nut, say one on the exhaust manifold. You know better than to try pliers or Vise-Grips, and also not to use an open-end wrench. You've hooked enough extensions together to give you clearance for your ratchet, so you can use a socket, the tool least likely to turn your 6-pointed nut into a no-pointed pain. Nevertheless, there's that sinking, buttery feeling as your socket rounds off all of the flats as soon as you lay any effort into it.

What you should have done is use a 6-point socket. Look at how much more metal has to be deformed before the 6-point slips. Then remember that exhaust manifold nuts are probably a little undersize from the heat-induced corrosion. It's a wonder the 12-point works at all.

6-POINT SOCKET

12-POINT SOCKET



Rotors That Rankle

I have a 1986 Olds Delta 88 with fwd and antilock brakes, and less than 20,000 miles. The car stops with a pulsating action, as though the brakes were being pumped. The dealer says the pads have become crystallized and caused the rotors to wear in spots. He says I need to have the rotors turned and the pads replaced. Can this be the fault of the antilock system? Will this happen again? R.E. JONES
ROME, GA

I don't know what the dealer means by crystallized, but I agree that the rotors need to be turned and, as always when the rotors are machined, the pads must be replaced.

The problem is not related to the ABS. The antilock system is only activated during periods when the wheels would otherwise be locked. That should be very rarely—and the amount of time the ABS is activated is so short that the amount of wear is insubstantial.

The real cause is portions of the cast-iron brake rotors being harder than others, wearing less and causing high spots. Will it happen again? Maybe, and if so you'll have to replace the rotors (and pads).

Brakes In Winter

If I park my '87 Maxima on rainy or slushy evenings and the temperature then goes below freezing, the rear wheels are locked in the morning. The dealer says, "Yes, quite a few people are having this problem. Don't use the emergency brake in freezing weather." The owner's manual says always to use the hand brake when

parking. I suspect that the cable was freezing.

ALFRED SCHWARTZ
HEMPSTEAD, NY

I don't think it's the cable freezing, I think it's the brakes themselves freezing to the discs or drums.

I have several suggestions:

1. *Be sure the rear brake's self-adjusters are working properly, and be sure to use the brakes while in reverse at least once a day (which is what activates the adjusters). Be sure the splash shields/backing plates are intact to insure that a minimum amount of water gets between the drum and shoe.*

2. *Try riding the brakes lightly for two or three blocks before you park, building up a little warmth to dry out the brakes before the car cools.*

3. *In spite of what the owner's manual says, it's perfectly acceptable to park the car in PARK without setting the hand brake. I do recommend using the brake regularly, just to keep the mechanism from corroding and freezing permanently. Needless to say, if you're on a hill, you'll want to use the hand brake, as well as PARK, and turn your wheels into the curb, too.*

Hot Car

My '85 Caprice has a "hot soak" problem. On warm days, if I park it for 20 to 30 minutes, it's difficult to start. When it does start, it's likely to die for 30 seconds or so. The dealer has checked everything, and even installed a heat shield between the carb and intake manifold, but there's been no change.

PAUL VEGORS
ARVADA, CO

Since your car was manufactured in '85, the Reid
(Please turn to page 44)

CAR CLINIC (Continued from page 43)

vapor pressure of gasoline has gone up considerably. Higher vapor pressure translates into increased liability for fuel boiling, and vapor lock, which is probably your problem.

A car runs rough after restart until cooler fuel from the tank reaches the carburetor. Some vehicles, yours included, have methods of recirculating fuel continuously to the tank, but that's not much help until you get the engine to start.

Try to keep the fuel tank at least half full, so that the fuel in the tank doesn't get too hot before you shut it down. Remember that whenever the engine is running, at least some of the fuel is passing through the extreme heat in the engine compartment. You also might try insulating the fuel lines in the engine compartment.

Why is the Reid vapor pressure higher? Refiners are boosting the octane by adding lighter, higher-octane fractions like butane and propane to their blends, and getting a larger fraction of gasoline out of a barrel of crude oil. Most cars can cope with the increased pressure, but some, unfortunately, can't. Some brands of gasoline may be better than others on any given day, but don't count on that being true the next week.

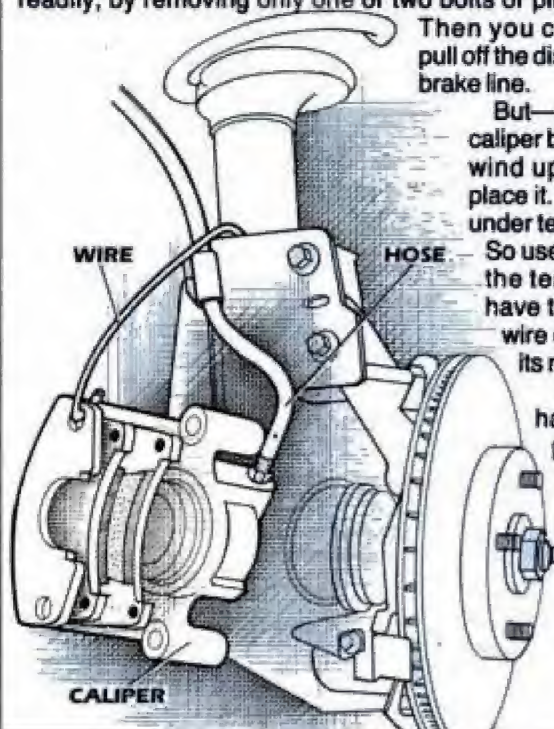
Just Hanging Around

Disc brakes are really pretty easy to work on. And they make the rest of the front suspension easy to work on as well, because the entire caliper comes off readily, by removing only one or two bolts or pins.

Then you can pull off the disc or strut without removing the brake line.

But—if you just hang the heavy iron caliper by the thin rubber hose, you will wind up removing the hose—to replace it. That hose isn't designed to be under tension. It's pretty fragile, in fact. So use a piece of wire or rope to take the tension off the hose while you have the caliper off. Tie or hook the wire or rope to the caliper by one of its mounting holes.

Just remember that if you hang it from the strut, as we've pictured here, and you remove the strut later, you'll have to hang the caliper from something else. You may also need to remove the clip that anchors the hose to the strut.



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Winston

FILTERS

WINNING

Thirsty Bunny

I ran out of fuel in my Rabbit while searching for a station that sold diesel fuel. Before running out of fuel, I noticed a station that sold K-1 kerosene. Tempted to try the kerosene, I reluctantly passed by. Running completely out of fuel cost me \$40 in labor to have a mechanic prime the injector pump.

Did I make a mistake in passing by the K-1 Kerosene pump?

KEITH A. TOLAN
STAR CITY, WV

Diesel cars are becoming more rare, and diesel fuel is becoming more difficult to find in some areas. Different car manufacturers have different policies, but by and large, kerosene is an acceptable emergency fuel in automotive diesels. Note that road use taxes are not levied on kerosene intended for heating use—and using it in your car may be illegal.

If you're really desperate, even a gallon or two of gasoline will keep your bunny running. Gasoline does not have the kind of lubricating qualities that diesel fuel does, and you stand the chance of accelerated wear to internal parts in the (very expensive) injection pump. But if it would get me to a truck stop, I'd do it. Once.

Frozen Out

I have a 1982 Granada V6. I blew a freeze plug, and the motor got hot and stalled. I had a new freeze plug installed, and at the same time got a tune-up. Now my mileage has dropped to 10 mpg. I've had the carburetor, power valve, choke housing assembly and EGR valve and gasket replaced. It's costing me money to keep taking it to the garage.

STANLEY SOPCZYNSKI
HARBOR BEACH, MI

Stanley, take your Granada to a different mechanic and have him take a serious look at the internal health of the engine. Have a cylinder leakdown test done, because I think that the overheating has caused a compression leak—a blown head gasket or scuffed cylinder wall(s). If your engine got hot enough to stall from the heat, something of this nature seems very likely. And unfortunately, you're looking at a major engine rebuild to fix it, not just minor parts replacement.

PM

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Send your question to Car Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

SERVICE TIPS


■ Model year 1986 Pontiac 6000s may develop a moaning noise at low speeds. TSB 86-5-18 covers the installation of a dampener to the parking brake actuators to fix this.

■ Some 1986 1.4 or 1.7L Alliances or Encores may require repeated cranking due to a high-voltage spike caused by the starter motor. Replace the starter relay with resistor suppressed relay PN 8933 003 934.

■ Buick fwd LeSabres and Electras may need correct bleeding of the power steering to correct pump noise. Jack the front wheels up in the air and take the steering from lock to lock with the engine off—as many as 20 cycles may be necessary.

■ Replace Ferrari Testarossa alternator belts with new belts only, PN 127132. Do not reinstall used belts, even if they appear undamaged.

■ VW TSB 87-01/42 says that knocking noises may be caused by hardened grease in the C/V joints. Disassemble, clean and repack using high-temperature grease. Replace worn C/V joints with kit No. 251-598, which uses a larger diameter ball, for longer wear.



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TASTE

Collecting Old Mustangs

BY JERRY HEASLEY

THERE'S AN old adage that goes something like, "If you can't make money out of your hobby, what good is it?" Of course, there is the fun factor. But there are certain hobbies, and collecting old Mustangs is one of them, that provides the best of both worlds.

Imagine the glee, for example, of the collector who runs across a 1965 Mustang for sale. He checks out and finds a K in the fifth digit of the VIN, coding the ultra-rare, 271-horse 289 V8 engine as original for this chassis. This is the special high-performance V8, built in limited numbers, highly sought by collectors, and worth a big premium in a '65.

Parts hunting can be equally rewarding, highly thrilling, or about like a case of California 1849 gold-rush fever. It may be hard to believe, but a nice, original 1965-66 Mustang AM/FM radio is worth a cool \$1000, and we remember one collector finding a '65 coupe for sale that had one of these rare tuners. This was seven to eight years ago, and the price of the coupe was \$695. Needless to say, our friend grabbed the deal, replaced the optional radio with a stock AM-er, then sold this prized option for more than the entire cost of the car.

Mustangs have been popular since the day they were introduced, April 17, 1964. But they went through the normal depreciation curve before prices hit the up-

swing. Around 1975, early Mustangs were as cheap as ever. A '65 V8 coupe could be bought for \$350, in good used shape. Lots of enthusiasts grabbed up early convertibles, too, for this price or a little more, same for the fast-back. This was the preresoration era, when Mustangs were just used cars. But the mania had begun and prices were already skyrocketing.

That mania remains nearly unabated today. The hot collector interest remains in the 1964½-1973 models.

Mustang mania

As an illustration of price progression of early Mustangs, we know of a Mustang enthusiast who went to a national Mustang Club of America show in 1979 and came back with a 1965 Mustang GT convertible at the rip-roaring price of \$3500. And it was restored. This GT has changed hands since. But if the condition has remained the same, that car on today's market would fetch an easy \$18,000, maybe \$25,000 because it is a 4-bbl., original equipment GT, one of the

really hot early cars to own.

Perhaps this Mustangese is pure Greek to you, and you'd like to get into the hobby for the fun and profit of it all—which is the root of all the enthusiasm. We have some suggestions.

Clubs? There is a Mustang club in every city in this country, and probably as many as 25 or more in the big metro areas, especially Los Angeles, where Mustang is still king collector car. Getting to know the people in the club by joining is the key to success and the fast route to enjoyment of the hobby.

Fellow Mustangers take care of their own first. That is, the good deals are often swept up by club members, before the car is even advertised. So, stay close by the people who own the cars. Members are often telephoned first by people outside the club with cars and parts for sale.

Club members will introduce you to the whole wide world of Mustanging, from

Convertibles like this beautifully restored '64½ are among the most valuable Mustangs today.



the shows to Saturday night cruises to the literature and books you need to participate in the hobby. Reading is a definite key, so the various magazines on the newsstands are a great help, even with listings of clubs nationwide. But nothing replaces getting around the cars, asking owners questions, and finally, buying and selling.

The show circuit

Attend a club show. Immediately, you'll see the cars and get in on the conversation—esoteric little discussions on everything from 31-spline axles to Cobra highrise intakes, Autolite 4 bbls., Daggenham 4-speeds, CJs and SCJs, and on and on. This is the Mustang language, the lingo you'll need to converse and get into that first car.

Otherwise, there are always the classifieds. Every big newspaper has an antique and collector car section, which includes Mustangs. Hemmings Motor News, also available on the newsstands, is pure ads on

collector cars, including hundreds of Mustangs and Mustang parts in every issue. Generally, you'll have to travel to find the cars in Hemmings, or any of the national publications. That's the way the Mustang hobby is.

Auctions are another source of old Mustangs. It could be a local auction of small size, but to get at the good cars, you'll have to go to a national auction.

Ultracollectibles

Which are the hot Mustangs to buy and restore or collect? The 1965-66 models have the look everybody likes. No matter the engine or body style. If it's a 1965 or 1966, it's hot to own. But, among these early first-generation Mustangs, the gems are the GTs, the K-engined cars, the convertibles, the fastbacks and the Shelys.

Shelbys? Every Mustanger is working toward that Shelby. Someday. That's why they're sure bets. But prices have already skyrocketed on the 1968-70 big-block convertibles and the R-model race cars of 1965. There are some models still left at reasonable prices, however, and every Shelby is high performance.

As you may have surmised, performance is the all-pervading key to top value and future appreciation in Mustangs. Big blocks, built from 1967 through 1971, are sure bets. Boss Mustangs have likewise shown major growth in the past couple of years, and have high potential. Boss 429s, which fetched \$25,000 for a restored example in 1987, now cost in the \$60,000 range.

But, for less than \$20,000, you can buy a restored small-block Boss 302. Or, even less money will buy a Boss 351, higher in output than a 302, and just coming into its own.

We could go on with examples of appreciating Mustangs because the variety of models is astounding. Part of the fun is seeking out these specialties, like one of the Twister Specials of 1969, or a GTA of 1967-1968, or maybe a GT/CS (California Special).

Buy restored

Generally, it makes more sense to buy a car that is already restored, or that is in excellent condition ready to go, because you'll know exactly what you have in the car. In fact, at big auctions, generally what is going on is that dealers are trying to shake loose nice cars from individuals. Dealers want cars that are ready to go, with a guaranteed payoff.

If you have less money to spend, and you have both the tools and talent to restore, then buying a basket case is okay because Mustang parts are available for restoration from literally hundreds of specialty shops across the country.

All Mustangs are sporty little cars, so there is no worry of getting an orphan

that will be a slug on the market. But there are still the hot numbers to own, and there are the unexciting cars. This is where it pays to do your research before purchase. The bottom line is to make sure you like the car you buy. Otherwise, ownership is no fun, and rather than the Mustang hobby, maybe you should consider mutual funds.

Finding a car is not the hard part of the chase, since Mustangs were built in the millions, but finding a good car is. Originality is the main concern with Mustangs because generally, modifieds have a questionable value.

Rust, as always, should be your No. 1

enemy, and the time-honored test of a Mustang's solidness is inspection of the front cowl, easily done by pouring some water into the opening at the front of the windshield. Most Mustangs have some cowl rust, and if it is bad enough, this water will spill right into the cab and onto the floor pans.

When all is said and done, the good car will continue to go up in value, the good car being the factory-original Mustang, the one with the engine and options everybody wants, in the premium original/restored condition. Buying these cars guarantees an ample dose of fun and profit.

FM

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Propeller-Driven Machbuster

BY MICHAEL LAMM, Contributing Editor

SOME PILOTS and engineers think it's impossible: supersonic flight with a prop-driven airplane. But not Bill Montagne. The former dirt-track and motorcycle racer, competition engine builder and computer consultant from San Ramon, California, firmly believes he can break the sound barrier with his Oldsmobile V8-powered pusher. The secret, he feels, is in the propeller.

Montagne, age 35, didn't originally intend to bump heads with the sound barrier. All he wanted to do was build an air racer for the Unlimited Class in the Reno Air Races. His first engine was a 4-cylinder Offenhauser. But additional funding allowed him to build a highly modified 500-cu.-in. Olds V8, which now holds the promise of some 2000 hp. This much power translates, theoretically, into Reno lap times of 612-617 mph, easily beating the current lap record of 474 mph. This engine, by the way, normally aspirated and running on gasoline, powered a 1967 Corvette at Bonneville to 217 mph before the car spun out. The driver said he was at $\frac{5}{8}$ th throttle at the time.

The prop's the thing

Being that close to the sound barrier, Montagne figured why not go for it all. Actually, there were several initial reasons. People kept saying it couldn't be done. Why not? For one thing, conventional propellers would tear themselves apart. The centrifugal



Bill Montagne hopes to fly his prop-driven creation through the sound barrier, which would be an aviation first.

force of a heavy aluminum or steel prop would shatter the blades long before the craft could reach Mach 1. For another, the thick cross section of a normal propeller would cause airflow separation or cavitation at speeds approaching supersonic, so the efficiency just wasn't there.

Montagne, though, figured he could beat all those problems. With help from NASA's Ames and Lewis research centers, he developed a very thin-section, very wide-chord 4-blade propeller with a high degree of sweep. For strength, it's made of solid carbon fiber and is only 60.5 in. in diameter. The tips are knife sharp, and the airfoil sections are relatively shallow. So there's high effi-

ciency with no cavitating. Carbon-fiber construction gives well over 10 times the tensile strength of aluminum, along with much greater resistance to flexing. At 5000 rpm, this unusual propeller should power Montagne's needle-nosed, 2500-pound F-5 look-alike to well past the speed of sound.

The mid-mounted, water-cooled Oldsmobile V8 uses an axial-flow supercharger of Montagne's own design. This is driven off the underdrive gearbox, which brings the engine's 8000 rpm down to the prop's 5000 rpm. The supercharger pressurizes a custom-fabricated intake system that includes con-

stant-flow port fuel injection. The 90-gallon tank permits a 15-minute fuel supply at full throttle.

Power parts

Olds competition aluminum heads take cooling water in at locations near each exhaust valve. Water exits the block near the crankcase and is circulated by a Montagne-designed aluminum axial-flow pump that circulates up to 250 gallons per minute. The external scavenging oil pump is likewise axial-flow. The forged Lunati crank and



Machbuster's powerplant: a heavily modified 500-cu.-in. Olds V8.

camshaft were ground to Montagne's specifications, as were the forged Carrillo connecting rods and Arias aluminum pistons.

Behind the aircraft's compact gearbox stretches an 11-ft. steel driveshaft to the propeller. The shaft is held in four support bearings that allow up to 6 Gs of side loading. This wasn't necessary for supersonic flight but will be useful if and when the airplane races at Reno.

(Please turn to page 107)



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VOYAGER'S LAST CLOSE ENCOUNTER

Voyager 2's last stop on its journey through the outer planets of our solar system is mysterious Neptune.

BY TIM COLE, Science/Technology/Aerospace Editor
PM Illustration by John Berkey

VOYAGER 2—the little space probe that could—will pass within 3000 miles of the blue giant Neptune at 9 pm on August 24. This flyby—at the moment Neptune is positioned as the outermost planet of the solar system—will mark the end of *Voyager 2's* tireless trek among neighboring worlds. But it's also a beginning, as this indefatigable machine sails on at 27 kilometers per second toward the heliopause, the region where the effects of solar wind terminate and deep space, the interstellar medium, begins.

What makes this close encounter all the more remarkable is the fact that *Voyager 2* was never intended to make such an all-encompassing reconnaissance of our

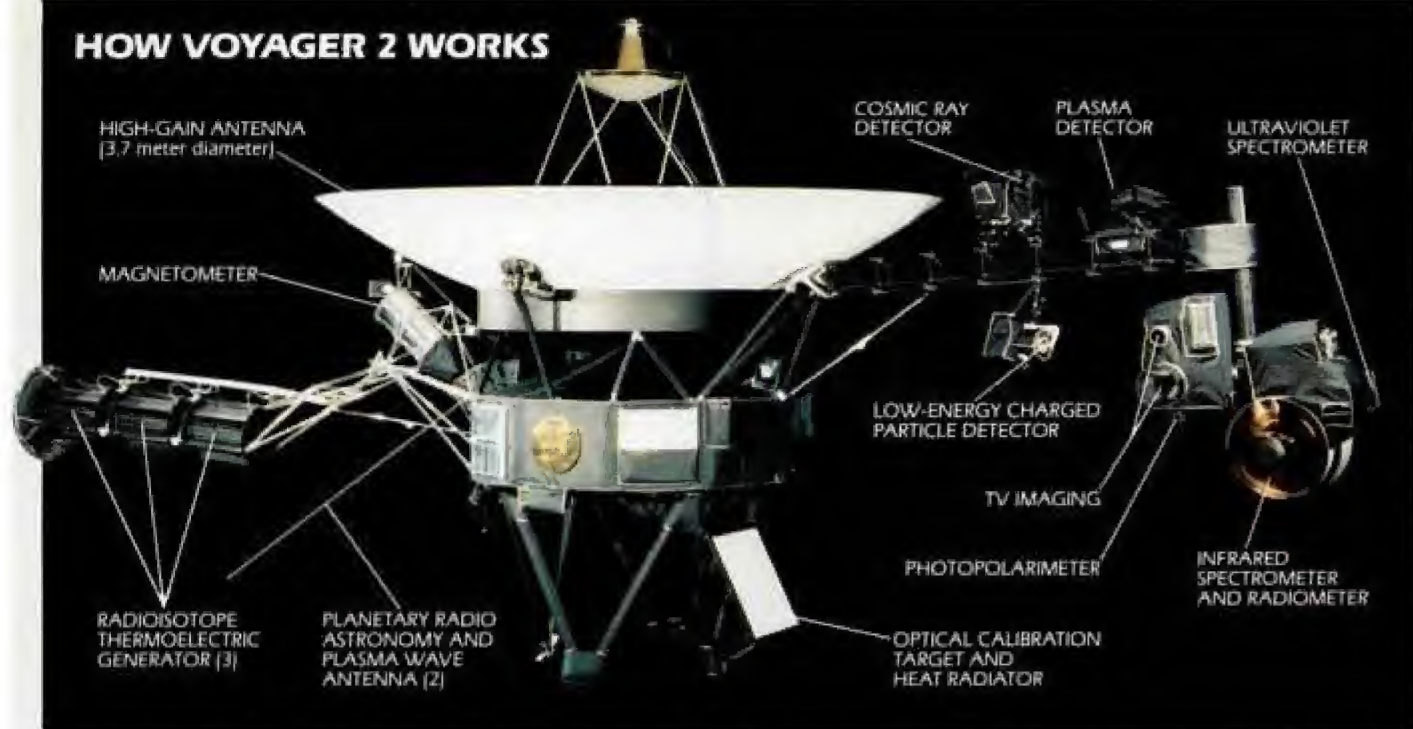
solar system. Launched on Aug. 20, 1977 (its sistership *Voyager 1* was launched on a different trajectory on Sept. 5, 1977), *Voyager 2* was designed to make closeup inspections of giant Jupiter and the rings of Saturn. A near-perfect alignment of Jupiter, Saturn, Uranus and Neptune made a clean-sweep feasible—each planet providing the necessary gravitational assist to send the probe on to its next rendezvous. Each encounter has fundamentally altered our knowledge of the planets.

The history of astronomy can be viewed as successive attempts to extend the gaze of the observer beyond Earthly limitations. Larger telescopes placed in high-altitude remote loca-

With its 3.7-meter high-gain antenna poised to send signals to mother Earth, *Voyager 2* makes its final approach to cloud-shrouded Neptune. Precision navigation from ground controllers will send the tiny probe over Neptune's north pole, avoiding the mysterious half-ring of boulder-sized particles that hugs the planet. Next stop: the heliopause, where the solar wind dissipates and the interstellar medium begins.

VOYAGER'S LAST CLOSE ENCOUNTER

HOW VOYAGER 2 WORKS



Precisely coded instructions from JPL controllers have sent *Voyager 2*'s versatile instrument package on its grand tour of the solar system.

tions continue to gather faint traces of light beyond our galaxy. The Hubble Space Telescope and other space-based gamma ray, X-ray and radiowave telescopes in the planned Great Observatories constellation will push man's reach to the edge of the known universe, allowing us to observe creation itself.

Following that theme, *Voyager 2* is a unique blend of astrophysics and astronautics, allowing Earth-based planetary explorers to view with thrilling clarity the curiosities of our home solar system. Consider just some of the results obtained thus far:

■ *Voyager 2* entered the Jovian system on April 24, 1979, permitting time-lapsed TV imaging of Jupiter's mysterious red spot for the first time.

Successive images revealed intense atmospheric circulation around the spot, and indeed within the horizontal bands that circumscribe the solar system's largest planet. *Voyager 2* also scrutinized the Jovian moon Io, one of the rare planetary satellites that experiences volcanism.

■ A 76-minute thruster burn just 2 hours after the Jupiter encounter put *Voyager 2* on course for Saturn and saved 10 kilos of propellant for later flybys. *Voyager 2* entered Saturn's system on Aug. 22, 1981, providing detailed views of rings made up of pulverized dust and boulder-sized rocks. Long thought to be homogeneous grooves or layers, much like a phonograph record, *Voyager 2* revealed that Saturn's rings contain irregular clumps of particles, possibly due to magnetic storms within the rings.

■ *Voyager 2*'s encounter with Uranus on Jan. 24, 1986, gave astronomers new insight into the planet's unique axis of rotation, which is virtually parallel to the planet's orbital plane. The phenomenon means that Uranus's wispy 9-ring system and accompanying moons—*Voyager 2* discovered 10 new ones—appear to circle the planet vertically. One of Uranus's moons, Miranda, provided a rich lode of geological diversity—with canyons, plains, valleys, escarpments, fractures and faults in a highly irregular pattern. Pocked by asteroids and meteors in some locations, devoid of external influence in others, Miranda is thought to have formed when various planetoids coalesced, broke apart, then reformed.

Next stop

The existence of Neptune was calculated—not observed—independently by John Couch Adams in 1843 and Joseph Le Verrier in 1846. Both astronomers detected perturbations in Uranus's orbit that could only be explained by the gravitational effects of a nearby planet of similar size. Thus, the discovery of Neptune became a triumph of celestial mechanics. The question regarding the makeup of Neptune's inner structure has changed as *Voyager 2* advances toward the planet. Current thinking has shifted away from a 3-layer composition of rock silicate core, an ion ocean of hydrogen and methane with an outer layer of hydrogen and helium. Now planetologists think Neptune has a relatively thick inner core of rock and ice surrounded by a thinner hydrogen/helium/methane envelope.

Preliminary views of the planet reveal a large bright cloud which remains in one place in the planet's Southern Hemisphere. Neptune also exhibits strong evidence of a magnetic field, radiation belt and auroras. In addition, Neptune radiates a comparatively high internal temperature—much higher than Uranus, which orbits 1.5 billion kilometers closer to the Sun. This fact has led astronomers to speculate that the planet is experiencing an unusually slow cooling of its primordial heat reserve.

Like all of the planets visited by *Voyager 2*, Neptune has rings, but they are thought to be only partially formed. Astronomers have used a method called stellar occultation to



A vital component in the *Voyager 2* mission is the Deep Space Network, a system of 70-meter receiving antennas like this one in Tidbinbilla, Australia.

determine the true nature of this aggregate of particles. Starlight gathered clearly on one side remains diffuse and obscured on the other side, obstructed, it seems, by the ethereal presence of Neptune's partial ring-arcs.

Scientists are also enthusiastic about Neptune's accompanying "ice worlds"—its moons Triton and tiny, remote Nereid. Triton orbits Neptune along the large planet's equator, but in a unique reverse, or retrograde, motion. It may have a surface of near solid methane, and liquid nitrogen may pool on the frigid moon's surface. In fact, astronomers believe Triton may have more in common with Pluto than Neptune. Nereid's orbit is inclined at 27° to Neptune's orbit, the largest eccentricity of any moon in the solar system.

Fantastic Voyager

The vast distances between the planets and their respective peculiarities make *Voyager 2*'s mission all the more taxing—and remarkable. For a decade, this tiny platform has served as the eyes of NASA's dedicated group of astronomers and physicists based at Pasadena's Jet Propulsion Laboratory. Marked by its 3.7-meter-diameter high-gain antenna—aimed continuously toward Earth—and thermal blanketing that provides some protection from micrometeoroid impact, *Voyager* has three payload booms for mission-specific experiments and power generation. Its 38.2 kilogram twin-camera imaging system has sent back all those fantastic views of the outer planets. We've received a multidimensional view of these strange worlds through an instrument package consisting of infra-



A unique alignment of the four outer planets has given *Voyager 2* a crucial gravity assist on the journey to Neptune.

red and ultraviolet spectrometers that identify the spectral signatures of the chemicals in the planets' atmospheres, a magnetometer used to sense magnetic fields, and a plasma detector used to analyze ionized gas mediums.

Because *Voyager 2* is operating far from the Sun, solar panels are useless for generating power. Instead, the probe relies on three radioisotope thermoelectric generators. The heat created by decaying plutonium is converted into electricity to power *Voyager 2*'s electronics.

The probe's brain consists of three computers—and three backups for a total of six—that act on orders from ground signals. Those signals travel at the speed of light to arrive at *Voyager 2* more than 4 hours and 6 minutes after transmission from JPL.

The central Computer Command Subsystem (CCS) issues instructions and serves as a fault detector. Two redundant microprocessors within CCS carry fixed or reprogrammable coding. The Attitude and Articulation Control Subsystem (AACS) aligns *Voyager 2* for data collection and transmission. The Flight Data Subsystem (FDS) collects and formats science data.

Navigation is performed by a sensor that takes fixes on the Sun and on Canopus, one of the brightest stars observable from Earth. Three gyros and an assembly of hydrazine thrusters maintain inertial reference.

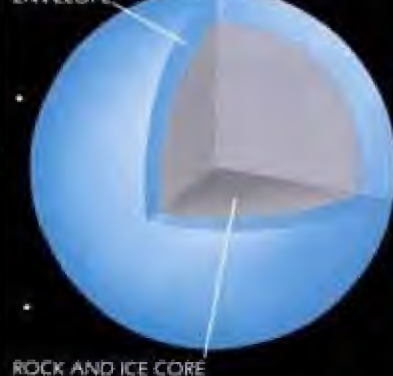
Voyager 2 also carries a gold-plated disc with samples of Earth culture—including photos of people and buildings, musical recordings and artwork, along with drawings of our solar system's location in relation to well-known quasars—should *Voyager 2* ever be retrieved by other life forms.

Although *Voyager 2* represents a significant achievement in electronics miniaturization, power generation and durability, its flight through space has not been calamity free. The primary radio receiver failed on April 5, 1978, and a backup has been used ever since. An actuator gearbox used to rotate a scan platform bearing instrument packages failed after the closest approach to Saturn. Ground controllers later determined that a loss of lubricant due to overuse caused the glitch, which mysteriously fixed itself on the way to Uranus when lubricant migrated back into the part. With an estimated 100 turns left before complete failure, scientists have been nursing the actuator ever since.

(Please turn to page 105)

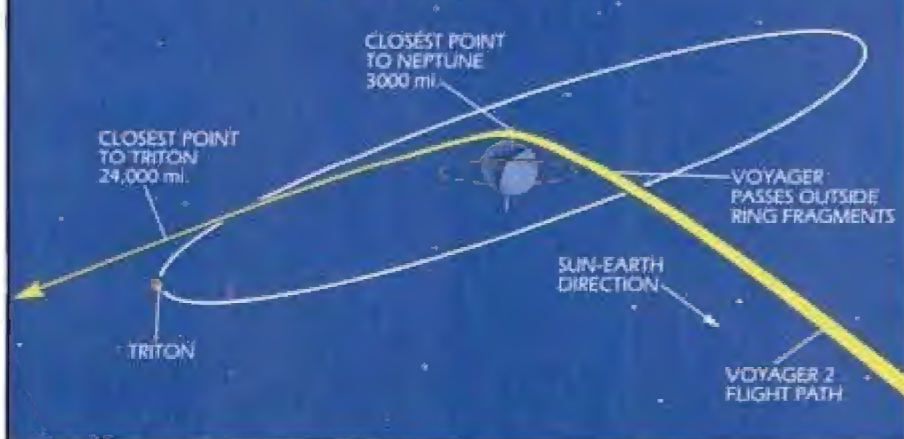
NEPTUNE'S POSSIBLE STRUCTURE

HYDROGEN—HELIUM—METHANE ENVELOPE



Hydrogen, helium and methane—which cause the planet's bluish green color—are thought to form Neptune's principal constituents. JPL ground controllers will learn more when *Voyager 2* passes within 3000 miles of the planet's north pole—the closest point of approach

VOYAGER'S NEPTUNE FLYBY AUGUST 24, 1989



In *Voyager 2*'s entire journey. The trajectory is designed to avoid Neptune's half-rings of boulder-sized particles. Final stop: Triton, before *Voyager 2* enters the interstellar medium. E.T.s that recover *Voyager 2* will learn about Earth from its picture and sound collection.



PHOTOGRAPHY

SHARP

Picture making gets better—and easier—every year. Here's our choice of the hottest new photo gear.

BY STEPHEN A. BOOTH,
Electronics/Photography Editor

SEPTEMBER marks the 150th anniversary of photography's debut. The art and the science have come a long way since then—but it's a good bet that Daguerre, Talbot, Eastman and other pioneers of the format wouldn't be surprised. They were, after all, men of vision.

Nonetheless, this year's crop of cameras and films is truly impressive. Advances in chemistry labs have yielded the most realistic print-films seen to date. The innovative incorporation of electronics in the camera virtually ensures that the images captured on film will be correctly exposed and focused.

In selecting our Top 10 photo products, we use the criteria established in past years: The item must be either the first of its kind, or advance the state of the art, or provide meaningful benefits to the user.

▲RICOH MIRAI

For many people, Ricoh's Mirai (\$795) is all the camera they'll ever need. This "bridge" camera combines the convenience of point-and-shoot compacts—such as automated focus and exposure control—with an SLR's manual control for creative effects such as multiple-exposure. You can't change lenses, but the 35-135mm powered zoom (70-200mm with teleconverter) covers most of the bases.



▲RICOH FF-7

The video age has made its mark on Ricoh's FF-7 (\$250). Like the company's XR-M and XR-P single-lens reflex models, the compact autofocus FF-7 has a specific exposure mode for taking photos from a TV or computer screen. This means you won't have to worry about synchronizing the camera's shutter speed to the monitor's frame speed when you want snapshot prints of scenes from your home video movies. Just press the tv button, compose your shot and fire.



▲CANON EOS 630

Canon's latest upgrade to its EOS line of 35mm SLRs is the model 630 (\$710, body). It combines the best features of original 650 and 620 models, and autofocuses twice as fast as either. Moreover, it offers pushbutton control to set the optimal shutter, aperture, metering and film-advance combinations for specific photos, such as sports, portraits, landscapes and group shots.

▼OLYMPUS INFINITY SUPERZOOM 300

With its 38-105mm autofocus power zoom and multiple, creative exposure modes, the Olympus Infinity SuperZoom 300 (\$600) built the first "bridge" between the point-and-shoot lens shutter compact and the more-versatile SLR. Among automated features, its viewfinder and flash zoom with the lens, and the lens tracks moving subjects—a feature usually not found in an autofocus compact, but only in autofocus SLRs. Creative options include multi-exposure, and slow-sync flash for nighttime shooting.



▼POLAROID 600-PLUS FILM

Just three years ago, Polaroid expanded the scope of instant photography with its Spectra cameras and vibrantly colored, rectangular-size Spectra film. Now, the new 600-Plus film packs Spectra chemistry into the square-format used by the earlier Series 600 and SX-70 cameras. This means whiter whites, sparkling greens and deep, saturated reds.



SHOOTING



▲MINOLTA MAXXUM 7000i

Minolta pioneered the autofocus SLR category with its original Maxxum 7000. The "i" in the new 7000i (\$838 with 50mm f/1.7 lens) designates intelligence. It focuses faster than its ancestor, and is able to track a moving subject by calculating its direction and speed 30 times a second. Focus—as well as optimal shutter speed and aperture—is fine-tuned right up to the instant of exposure. Additionally, a series of Creative Expansion Cards pops into the 7000i to optimize exposure for special shots, such as sports action, fantasy effects, portraits and more.



▲PENTAX SF-10

You get autofocus, and a built-in pop-up flash, in the Pentax SF-10 (\$757 with 50mm, f/1.7 lens). You also get a large parcel of the automated, preprogrammed features that electronic microprocessors have brought to the SLR. So many, in fact, that Pentax saw a need to build in a user's guide so you needn't constantly refer to the instruction manual. There's a large liquid-crystal display screen atop the camera with a diagram of the SF-10 and graphic indicators that flash onscreen to guide you through its paces. Although there is a wide selection of autofocus lenses for the SF-10, including some fairly compact zooms, older, non-AF Pentax lenses may be used with an optional adapter.



▲NIKON F4

Professional photographers waited a long time for the successor to Nikon's top-of-the-line F3—and wondered how the mostly manual workhorse would adapt to the age of electronics. The answer comes in the F4 (\$2500, body). It retains the full manual control over image-making demanded by pros—including compatibility with all previous Nikon lenses—while incorporating autofocus capability, preprogrammed exposure and a $\frac{1}{6000}$ -sec. shutter.

▼KODAK EKTAR PRINT FILMS

Once upon a time, you had to shoot finicky transparency films to get the ultimate in color, sharpness and grain structure. And if you wanted a print from your slide, you'd lose something in the translation. Kodak's new Ektar print film (available in ISO 25, 125 and 1000) has changed all that. Ektar 25 is the Kodachrome of print films, while the 1000 has the low grain of slower films. Though Ektar is intended for use in SLRs, it requires no special processing or printing.



▲CANON SURE SHOT ACE

This 12-ounce autofocus snapshotter is the first of its breed to boast wireless remote control. Meanwhile, the Sure Shot Ace (\$260) also incorporates a worthwhile feature from earlier cameras—the waist-level viewfinder. It's mounted atop the Ace, directly above the conventional eye-level viewer, and gives you additional options for composing your photo. In tight crowds, for example, you can hold the Ace upside-down above your head to frame a picture. Combined with the infrared remote, it makes for more relaxed and candid shooting, too.



HAPPY BIRTH

The original pony car celebrates its silver anniversary.

THE MAY/JUNE 1960 issue of the now-defunct *Sports Car Graphic* had an article titled "Meet The Mustang."

It featured a concept car based on Corvair components, designed by ex-GM stylists Pete Brock, Norm Neuman and Gene Garfinkle. It was a sporty coupe that featured a fairly long hood (for a mid-engined car), a short deck, a chopped off rear end and a squared off top that looks very familiar today.

Brock, who went on to design the Daytona Cobra among others, just smiles at the suggestion that these sketches might have inspired the Ford Mustang.

Remember that this would have been very early in '60. The Big Three had just introduced their compacts—Ford Falcon, Chevy Corvair and Plymouth Valiant. The clear sales

winner at the time was the Falcon. But already, the trend was clear. The American public wanted even sportier cars. Adding bucket seats to a Falcon or Corvair wasn't going to cut it. Ford product planners and designers had their finger right on the pulse of the trend. The Mustang was already going through the early development stages even as the Falcon was hitting the showrooms.

By the end of 1963, the Mustang was already past the prototype stage and ready for production. It had styling that traced its lineage to the original Lincoln Continental, not to mention several high-priced European GTs—long hood, short deck—and mechanicals straight from the Falcon.

The directive that produced the new car said it had to be small, light, inexpensive, capable of seating four, and had to possess the long hood/short deck.

Some evidence of Ford Design thinking was the Mustang I concept car. Mustang I was a 2-seat mid-engined roadster built around the Ford Taunus 12M V4 front-drive package moved to midship. It had a space frame, aluminum body and Lotus "wobbly web" wheels. Begun in May 1962 and displayed in October, it was already a dead issue for production. But it was Ford's first public use of the Mustang name.

In 1963, Ford showed the Mustang II, a closed coupe concept car that, even today, looks remarkably like the production Mustang of the following year. There was no doubt that the new car would be based on Falcon components. Falcons had unit bodies with double A-arm front suspensions, coil springs mounted above the upper arms, leaf springs in the rear. The basic Falcon had small drum brakes all around, a cast-iron inline Six with the intake manifold cast into the head,



1964 1/2 GT CONVERTIBLE



1967 GT FASTBACK



1971 BOSS 351

DAY MUSTANG!

BY LEN FRANK, PM Photos by Ron Hussey

and a choice of a 3-speed manual or 2-speed automatic transmission.

By the time the Mustang project was given the official blessing, the Falcon Sprint had a V8 and a 4-speed, with front disc brakes on the way. Ford's long-range plan was to spend \$250 million to refurbish the whole line for 1965. But there was no budget to introduce a new product before those new '65s arrived.

Lee Iacocca, now chairman of Chrysler Corp., was heading up Ford Division in those days. He's generally given credit for being the father of the Mustang. But incredibly, the first proposal for the new car was turned down by management in 1962. Iacocca tried again soon after, and sold the idea to Henry Ford II. With Mr. Ford on his side, it became a go. Iacocca, with a comparatively meager budget, set an almost impossible timetable for production. There was almost no time for redesign, no time for committee approval, no time for mistakes.

That all worked to the benefit of the new car. The final design was remarkably close to the original Mustang II and the first production car rolled out just 18 months after the project's approval. The car reached the public on April 16, 1964, as a 1965 model. Production was set at 75,000 for the first year. They actually built—and sold—over 303,000 units.

The 1964½ (actually 1965) Mustang arrived with choice of a 170-cu.-in. Six or the 260-cu.-in. version of the small-block V8—same as the Falcon, as per the plan. Eights outsold Sixes, automatics outsold manuals, 3-speeds outsold 4-speeds.

The notchback hardtop was the runaway best seller (about 410,000 hardtops, 77,000 fastbacks, 73,000 convertibles) for model year 1965. A 289-cu.-in. version of the V8 was a running change, eclipsing the 260 as soon as it was ready for production.

Strength followed strength and the

'66, essentially the same car as the '65, sold 50,000 more than '65.

In 1967, the car was redesigned. It was bigger, heavier, brawnier and you could order a GT version with a 390-cu.-in. engine. Sales dropped. This was right in the middle of the musclecar wars in Detroit and the Mustang was not at the top of the performance heap. Any number of cars could blow away any Mustang in a drag race. Including a new competitor—Chevrolet's newly introduced Camaro, which could be ordered with a 396-cu.-in. engine rated 375 horsepower (actually it produced 425 hp).

In '68, the top option was a 428 Cobra Jet Ram Air engine. In 1969, you could order Boss 429 and Boss 302 Mustangs and a Mach 1 option that was the equal of Chevy's Super Sport option on the Camaro. Still, sales continued to drop each year. As the car got heavier, larger, more expensive and cost more to insure and operate, sales dwindled and some Mustang enthusiasts yearned for a return to the



1989 GT CONVERTIBLE



1978 KING COBRA



1979 FASTBACK



1969 MACH I

original concept of the car. The low ebb came in 1971-73. The car was redesigned again and the original Mustang was buried under ballooning sheetmetal. Overall length was up 8 in. and the car weighed over 500 pounds more than the original.

By 1973 it was hard to see any reminders of the simple little 1965 coupe that might be hiding under a Mach I, with its smog-controlled 351. It was clearly time to move on.

But the 1974 Mustang II (not to be confused with the concept car) was not the answer. The new car was based on the Pinto, not a great place to start but no more mundane than the Falcon.

Mustang II was shorter than the original, but had more overhang and curb weight. Where the original had been fresh, the new one was a baroque imitation. Its engine was the 2.3-liter (140-cu.-in.) sohc Four—basically reliable, but also rough and noisy.

Nevertheless, sales skyrocketed to nearly 300,000 (from about 120,000 in '73). But after that banner first year, sales dropped in each year of production of the Pinto-based Mustang, save for the last, when they recovered slightly.

A 2.8-liter German Ford V6, borrowed from the Capri, became an alternative engine from '74 through '78. It "improved" 0-60 times to the 14-second range. A 302-cu.-in. V8 option in '78, at 133 bhp, shaved about 3 seconds off that, but no more.

The current Mustang, introduced in 1979, was based on the Fox platform used for the Fairmont and T-Bird. The availability of the 302 V8 as an option made the Mustang one of the hottest cars you could buy in smog-engined 1979. And you could even order a 4-speed manual transmission, just like in the good old days.

Ford product planners recognized the strong sales of V8-engined Mustangs and introduced a Boss version

in 1981. The Boss model marked Ford's official return to the high-performance market category. As sales soared, so did the GT and LX models with special handling components and up to 225 horsepower in today's versions.

Ford tried a different tack with the SVO Mustang. A turbocharged version of the 2.3-liter Four was available

from 1979 through 1984. The engine led to the SVO version, with considerably revised styling, greatly improved intercooled engine, improved suspension, 4-wheel disc brakes and 5-bolt hubs, to name just a few of its enticements. It was an interesting car, but no sales winner.

By the time the SVO experiment was underway, a convertible Mustang was also available, the first one in a decade. But the writing was already on the wall. Americans once again wanted horsepower and cubic inches. The SVO faded away and the GT with the 5.0 liter HO V8 became the car to own if you were a young man who wanted to make a statement to his friends.

Today, the Mustang is riding high. Plans are to keep the current Mustang in production for the next five years, through 1994, with continual small improvements but no radical change. Which is very good news indeed.

PM



1970 BOSS 302



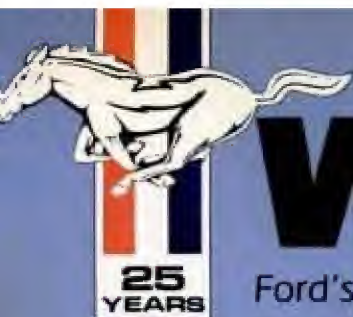
1971 MACH I



1983 LX CONVERTIBLE



1984 1/2 SVO



WAR HORSES

Ford's ponycar has been doing battle on America's racetracks for 25 years.

BY RICH TAYLOR, Contributing Editor

Still potent after more than two decades, G.T. 350 Mustangs race regularly in historic events.



MOST AMERICANS call a Mustang a coupe. But a Mustang has seats for four, which by some definitions makes it a sedan. Sedans race in FIA Appendix J, Group 2, and in 1964 there were no FIA Group 2 races in the United States. So the first Mustang race cars competed, ironically enough, in Canada and Europe.

The first Mustang ever to be raced anywhere was a white notchback owned by Chuck Rathgeb of Comstock Racing that ran in Canada in the spring of 1964. It was built and driven by Paul Cooke. Stripped to 2500 pounds, fitted with a Weber-carbureted 289 V8 rated at 384 hp, 7.50x15 tires, a Galaxie rear axle and the usual full-race

suspension modifications, it was clocked at 142 mph at Mosport.

Across the Atlantic, Ford had been racing Galaxies and V8 Falcons in the British Touring Car Championship and FIA international rallies since 1961. Since a competition Mustang was mechanically identical to a competition Falcon Sprint, it was little trouble to turn a couple of the first Mustangs in Europe into rally cars not all that different from Comstock's racer.

Bo Ljungfeldt/Fergus Sager and Peter Proctor/Peter Harper first ran the factory entries in the Spa-Sofia-Liège rally, both teams crashing somewhere in Yugoslavia. At



Zakspeed's IMSA racer was probably the ultimate Mustang.



Parnelli Jones making a pit stop during '70 TransAm race.



25
YEARS

PM PONIES

Racing really does improve the breed.



PM PHOTO BY HUMPHREY SUTTON

BY MIKE ALLEN,
Assistant Automotive Editor

YOU'LL REMEMBER our racing adventures last year, when Auto Editor Tony Swan, myself, Contributing Editor Rich Taylor, and former West Coast Editor Len Frank raced a Saleen-prepared Mustang LX. That's a picture of us and our crew (opposite page), right after winning the Longest Day of Nelson Ledges.

This year, Steve Saleen, the guy who builds the best-looking, fastest Mustangs around, has built a limited run of 250 SSC models. We'll be racing one of them in several endurance events, beginning with a return to Nelson Ledges to defend our championship title.

Car number 54 has been turned into a backup car, and we'll be racing it in a few selected club races through the season to stay sharp. It's been repainted shiny black, and this season will wear number 25 (above). Our new Saleen SSC also wears number 25 (right). If you don't recognize the white-with-blue-racing-stripes paint scheme, check out an original 1965-66 Shelby G.T. 350 photo. Of course, the number 25 has special significance to Mustang enthusiasts this year.

Our SSC started life as a complete running Mustang. The changes that transform a regular Mustang LX 5.0 into a Saleen SSC begin with the engine, the venerable 302 V8. All HO versions of the 302 utilize Ford's EEC-IV direct port fuel-injection system. But in the conversion to SSC, Saleen replaces the stock 60mm but-

terflies with 65s. Saleen installs a different intake manifold, and replaces the intake valves with 1.90-in. intake valves. A special mass airflow sensor, recalibrated computer, revised ignition advance curve, and a high-lift cam mean you can forget about anything but 94 octane gas. But these changes also mean 290 hp and 300 lb.-ft. of torque. Other modifications include electronically controlled shocks, stainless-steel headers, re-

vised ratios in the trans, and an Auburn limited-slip differential.

Once the car is a Saleen SSC, then actual race preparation can begin. Actually, a rollcage, fire extinguisher, window net and tape on the lights (to keep glass off the track in case there's a little shoving) constitute all of the required preparation. But if anybody actually showed up in a car that had received no more preparation than that, they'd have to have binoculars to



see the rest of the field.

The engine is removed for a complete rebuild, starting with a thorough static and dynamic balancing of all the moving parts. Lightening, increased compression ratio, porting and polishing are all illegal. But the engine can be rebuilt to precise tolerances. This ensures that there is identical compression in all eight cylinders, that ports in the manifolds match the ports in the heads, that the Top Dead Center mark on the crank pulley is true TDC, and that a hundred other fussy details are checked and brought up to optimum spec for peak efficiency. If you went through a properly blueprinted engine with a micrometer, you wouldn't be able to find any dimension that Ford hadn't specified as correct for a new 302. This ensures not only long engine life, but also is good for 10 to 25 hp. A Walker Dynomax exhaust system helps the hp count, too.

The chassis is also blueprinted. To start, most of the Ford suspension bushings are replaced with harder



Last year our team won the Nelson Ledges 24-hour Endurance Race and here we are in the winner's circle.

urethane biscuits, to reduce compliance under hard cornering. Monroe builds shocks and struts with special, race-only calibration. High-rate springs front and rear and stiff anti-roll bars keep the car flat in hard cornering. Alignment settings include plenty of negative camber, and as much as $\frac{3}{8}$ -in. toe-out for good turn-in. Other race-only accoutrements we installed include a Recaro racing bucket seat, auxiliary driving lamps from Bosch to turn night into day during the wee hours of a 24-hour race,

and Kenwood FM 465 Mhz radios to keep the driver in touch with the pits.

Tires are General XP2000V—245/50VR16 in front, and 255/50VR16 in the rear—mounted on 8-in.-wide American mags. We were really impressed with the Generals during our thousand-odd laps of Nelson Ledges last year, with temperatures ranging from 104° F to 55° F and some monsoon rains thrown in for good measure. However, like all the DOT-legal tires used for SS

racing, our Generals are shaved to only a millimeter or two of tread depth, for less squirm in corners.

Other sponsors include Polyshield and its great line of car care products, Setcom communications gear, Motul synthetic lubricants (which are necessary because of the 300° oil temps—the rules preclude the use of accessory coolers) and Motorcraft plugs and filters. And let's not forget Ford for supplying the base car, and a 460-cu.-in. Ford van as a tow vehicle. Hey, let's go racing!

PM



PM PHOTO BY G. PHOTOGRAPHIC



MILLENNIUM MUSTANGS

Forecasting the shapes of the next decade — and the next century.

BY JIM DUNNE, Detroit Editor; PM Illustrations by Duane Kuchar

HOW LONG WILL the present incarnation of the Mustang satisfy buyers and appeal to the public? That's a tough call, one that Ford management is grappling with right now. In the near future, Ford brain trusts will again face decisions that will determine Mustang's fate. The car is scheduled for a major changeover in the early 1990s, probably the 1993 model year. The question of spending hundreds of millions of dollars to update the present Mustang design, or switching to something entirely new must be answered soon, since it normally takes three years to put changeover plans into production.

Ford is already partially committed to spending \$270 million for updating the current model in 1991. That program includes rearranging the sheet-metal—fenders, hood, trunk and roof—but it does not touch on major changes to the chassis and

drivetrain. A major overhaul includes a new floor pan, front and rear suspension, possibly engine and transmission as well as the greenhouse, and would cost the company close to \$1 billion. An investment of that size is not made without close scrutiny as to where the Mustang program is now, and where it should be heading.

Finding out where the Mustang is right now is the easy part. Sales for the first part of 1989 are at a 195,000-per-year rate, almost double that of the Chevrolet Camaro and far ahead of the combined sales of Camaro and Firebird, its natural competitors.

Ford expects more of the same success for future Mustangs. But it must decide quickly how it expects Mustang to stay a sales leader through the '90s. Three of the current choices:

■ Carry on with the present Mustang styling, but with yearly facelifts.

■ Switch to a high-styled, futuristic body like the Probe or the upcoming Camaro/Firebird.

■ Build an all-new Mustang off the Thunderbird chassis.

Of all the options, it looks like Ford insiders prefer keeping the current Mustang theme, and not adopting the futuristic designs of a Probe or a next-generation Camaro.

"We want to keep Mustang's image," says Fritz Mahew, chief design executive for all Ford cars. "The car is not like anything else on the road. Besides being light, nimble, husky and strong in appearance, it has a classic American performance look. Future Mustangs will continue the long hood, short deck profile. And soon we will go back to an eggcrate grille."

But, no matter what Mahew and his designers plan, the Mustang must get





some updating to match the new styling of the 1992 Camaro. Cowl height will be lowered, the windshield posts will be angled back more sharply, and the whole car will be lowered slightly. Doors will be thinner, lighter in weight. And the car will have a muscular stance with little body overhang and a wide tread.

"We raised the cowl on the 1979 Mustang 1 in. to give the front a wedge look," explains Mahew. "That still contributes to the appeal of the Mustang. And we plan to keep that line."

Dearborn decision-makers

also look inside the sheetmetal for answers to Mustang's future.

"We want to continue to offer a car that's fun to drive, exciting to own," comments Gale Halderman, a Ford design executive who was involved in many early Mustang decisions. "We want to keep the 2-plus-2 seating arrangement. And, passengers will still sit low in the car, more like putting the car on as you would a suit."

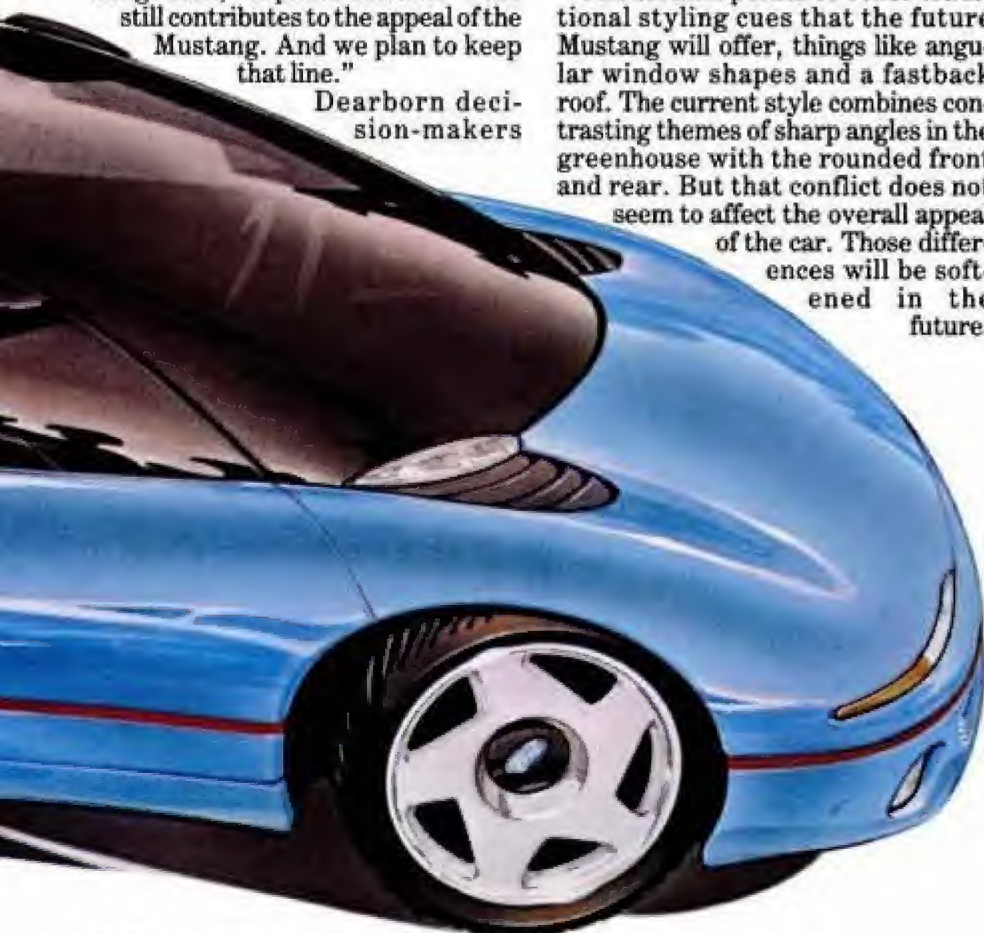
Halderman points to other traditional styling cues that the future Mustang will offer, things like angular window shapes and a fastback roof. The current style combines contrasting themes of sharp angles in the greenhouse with the rounded front and rear. But that conflict does not seem to affect the overall appeal of the car. Those differences will be softened in the future.

New shapes to look for will include a longer wheelbase in proportion to the length of the car, and a much lower cowl below a faster windshield.

Nostalgia and image are two features that buyers like in the Mustang, features that are sure to keep the car's sales momentum strong over the next few years. Just as important is the model lineup, with the fastback and notchback coupes and the convertible making Mustang the most versatile line in the sporty car field. It is interesting to see that sales totals of the two hardtops is about equal. Buyers are split evenly on which they like better. Convertible sales are running strong at about 15 to 20 percent of all Mustangs, and plans are to keep a ragtop as part of the 3-model lineup.

"What we offer in the Mustang GT is affordable performance," according to Ken Dabrowski, Ford's program manager for Mustang. "And that's what we're designing the future Mustang for. Its V8 engine and rear drive are different from the pack. The car feels like an F-14 on takeoff."

One route that Mustang will not follow is front-wheel drive. That's made clear by every Ford executive who has anything to say about Mustang's future. When you get right down to it, there isn't a whole lot of difference in basic features between the first Mustangs and the ones you see in showrooms today. And Ford execs intend for the car to stay that way. Which means rear drive is definite for the future. "Right now," reports Dabrowski, "customers are telling us they like what we're offering. Mustang is a distinctive car with a rich tradition. We want to keep that. We want a Mustang to be a Mustang." **PM**





COMPARISON TEST

PAST AND

Twenty-five years have definitely wrought changes in the Mustang's performance capabilities, but the bloodlines are clearly evident.

BY RICH TAYLOR,
Contributing Editor
PM Photos by Ron Hussey

TWENTY-FIVE YEARS after its birth, the Mustang GT has evolved into something pretty different from what it was on April 16, 1964. That's partly because the car has changed—matured, grown, blossomed into a world-class, high-performance car. And partly because the world has changed. What seemed like a small compact in 1964 is a full-size muscle-car today.

To measure the Mustang's progress, we brought a mint original



Interior styling of original Mustang was mid-'60s sporty, with plentiful brightwork and skinny, wood-rimmed wheel. This car's special Pony interior was an extra-cost option. The 289 V8 could be had in three output levels, ranging from 200 hp [gross] at 4400 rpm to 271 hp at 6000.



PRESENT



Current Mustang GT instrument panel is typical of current sports and GT machinery—all black, with white-on-black analog instrumentation. Padded wheel affords superior grip. Solidly established 302-cu.-in. HO V8 produces 225 hp [net] at 4400 rpm, 300 ft.-lb. of torque at 3000.

1964½ GT convertible and a new 1989 GT convertible to our usual test track. To create a level playing field, we replaced the original tiny tires on the '64½ with a set of 215/60R15 Good-year Eagle GT tires similar to those on the 1989 Mustang GT. And then we ran both cars back-to-back through our normal battery of tests.

The results are surprising. Read the spec pages side by side, and there's not all that much difference to show for 25 years. Today's car has computer-controlled fuel injection instead of a 4-barrel carburetor, and roller rockers and hydraulic pushrods instead of mechanical lifters. But the basic Ford small-block V8 hasn't changed much in nearly 30 years.

The rest of the chassis is completely different, and yet very much the same, too. We're still talking about a front-engine/rear-drive design with unit body/chassis, independent front suspension with rigid rear axle, front disc brakes and rear drum brakes.

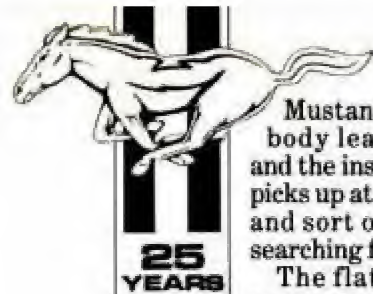
The wheelbase is now 8 in. shorter, but the overall length is within 2 in., the width and track within 1 in., and the height literally identical. Even the brake rotors and drums are virtually the same dimension as they were back in 1964.

The biggest difference in the spec box is that the 1989 Mustang weighs about 250 pounds more, thanks mostly to safety equipment, add-on plastic bodywork and electronic convenience features that weren't even thought of 25 years ago. Comparably equipped, today's Mustang GT and yesterday's would weigh pretty much the same.

Even at the test track, there wasn't a dramatic difference as far as absolute performance goes. The 1989 Mustang is slightly quicker and faster in a straight line, slightly quicker around a corner, and a bit better at stopping. All that is thanks to a little more horsepower, more torque, better gear ratios and a better-controlled rear axle.

On paper, at least, you'd think there wasn't much difference between our two Mustangs, certainly not a quarter-century worth. And you'd be wrong. Today's Mustang GT may be roughly the same size and deliver about the same performance. But given the basic parameters of a V8 2+2 sporty car, a 1965 Mustang GT and a 1989 Mustang GT couldn't be more different.

Mostly, it has to do with feel. A '64½ Mustang feels like an old car. The suspension travel is limited, the leaf-spring rear axle is virtually uncontrolled over bumps, and there's a tremendous amount of noise, vibration and harshness transmitted through the front subframe. The old



Mustang shows lots of body lean in a corner, and the inside front wheel picks up at a curious angle and sort of reaches out, searching for the road.

The flat little bucket seats are surprisingly comfortable, but the skinny-rimmed plastic steering wheel sits too high and close to your chest by modern standards. And the steering is remote and too light. The shifter on the old C-4 automatic is as slick as ever, and when you put your foot on the gas there's a satisfactory roar and leap forward. But the brake pedal feels as dead as stepping on a 2x4.

By comparison, the 1989 Mustang GT feels all of a piece. It still betrays its economy car Fairmont origins when you get near the limit on a rough road. There's not enough suspension travel, and there's some cowl shake with the convertible. But compared to the early Mustang, it feels much more solid and secure.

Indeed, the new Mustang GT feels a lot better than you'd expect for a car



Our 1964 1/2 had optional deluxe Pony Interior. It's worth a premium on the collector market.

with such a conventional design. The overdrive automatic has the V8 barely ticking over at highway speeds, and the car seems strong, smooth and bulletproof.

It's also pretty comfortable, with contoured bucket seats, fat-rimmed steering wheel and a full set of instruments. Upholstery material, door panels and dashboard are well-finished and handsome. By comparison, the early Mustang's skimpy gauges and cheap vinyl door inserts seem pretty down-market.

There's also the obvious difference in styling. The add-on plastic air-dams, spoilers, running boards and intakes give the '89 Mustang GT a heavy, ponderous look. It may be more macho, but sure not as pretty.

Not the way a '64 1/2 is pretty. And that's the appeal. An early Mustang is not as good a car as an '89, from an engineering standpoint. It's less sophisticated by any standard, but unfettered by aerodynamic considerations, impact bumpers, crush zones and all the rest. Back in 1962, stylists Joe Oros and Dave Ash could draw a car that didn't have to do anything more than look good.

And it does. It still does. As Lee Iacocca said, "There was magic to this car." The magic still works. A new Mustang GT is a good car, maybe a great car. And at \$18,000 for a fully equipped convertible, it's something of a bargain for a car that will go 140 mph and is almost guaranteed to be a collector's item 10 years from now.

But a 1964 1/2 Mustang GT is magic. A decent driver will cost you \$10,000-\$15,000. A concours convertible can be more than \$30,000. We promise you, it will put a smile on your face, whether you drive it or just look at it in the driveway.

It will also be an appreciating investment, and attract more favorable attention from the people you meet than any Ferrari. Even after 25 years, that magic is undiminished. **PM**



COMPARISON SPECS

1964 1/2 GT

Base Price	\$2557
Price As Tested	\$3854
Engine Type	289-cu.-in. V8
Engine Horsepower	210 @ 4400 rpm
Engine Torque	282 lb.-ft. @ 2400 rpm
Curb Weight	2980 lbs.

Performance

0 to 60 mph	7.5 seconds
Quarter-mile	15.7 sec. @ 89 mph
Braking, 60 to 0 mph	185 ft.
700-ft. Slalom	54.08 mph
200-ft. Skidpad	.74G
Fuel Mileage	14.5 mpg

1989 GT

Base Price	\$17,912
Price As Tested	\$18,975
Engine Type	302-cu.-in. V8
Engine Horsepower	225 @ 4200 rpm
Engine Torque	310 lb.-ft. @ 3300 rpm
Curb Weight	3250 lbs.

Performance

0 to 60 mph	6.5 seconds
Quarter-mile	14.5 sec. @ 95 mph
Braking, 60 to 0 mph	116 ft.
700-ft. Slalom	59.75 mph
200-ft. Skidpad	.82G
Fuel Mileage	16.75 mpg

COMPARISON TEST

CUDDY CRUISERS

Agile, midsize cuddies come of age with big-boat style and roominess. We match them up for a head-to-head showdown.

BY TIM BANSE; PM Photos by Skip Gandy

PARADISE, once considered lost, has been found today, often with a vengeance. If accessible, most places of natural beauty are crowded, commercialized or off limits. One exception, fortunately for boaters, is on the water, where there are islands, coves and idyllic backwater havens still out of reach to automobiles and crowds.

We found such a place on Florida's Little Gasparilla Island, a long finger of deserted, white-sand beach studded with sea shells and flanked by pine, palm tree and mangrove forest. It's the kind of place, located on the Gulf Coast, where you pitch a tent for a day of fishing, a picnic and then linger long past sunset.

We also found the perfect boat to take us to this blue-water heaven. In fact, we found four of them, each about 22 ft. long with lots of deck space, ample seating, roomy cabins and the comfortable feel of a full-size sedan. Each was rigged with a MerCruiser 5.7-liter, 260-hp Alpha One sterndrive, a power package with enough torque to get on plane quickly and deliver impressive top-end speed.

For three dawn-to-dusk days, the test team wrung out the quartet of boats to see how they compared. We used radar gun, stopwatch, measuring tape and a critical eye. Interestingly, the test re-

sults were extremely close and only a couple of points—a split second here, a square foot there—separated the first-place and fourth-place boats. The difference between them, we discovered, was by design rather than execution, and a boater looking for an affordable, trailerable day cruiser would be happy owning any of the evenly matched boats in our fleet.



EBBTIDE 224 CATALINA CUDDY XL

CUDDY CRUISERS



LARSON HAMPTON 220

Celebrity 231 SE Cuddy

First-place honors go to the classy Celebrity 231 SE Cuddy, a good-looking pocket cruiser combining ultramodern Eurostyling with traditional marine values.

The smooth-running Celebrity blew away the competition in acceleration trials and finished second on the performance course. It lags behind the fleet at the top end, but gut-wrenching speed isn't the reason you buy a boat like this and 45 mph is plen-

ty fast for a family cuddy cruiser.

At speed, the rig handles superbly, tracking straight and true. During hard, wide-open-throttle turns it feels nearly as responsive as a water-hugging sport boat.

Without benefit of a walkaround deck, the Celebrity solves the problem of bow access by means of a walk-through windshield and sliding cuddy hatch. This arrangement also serves to open up the cabin for a good amount of ventilation and light.

Fit and finish is another strong area (ranked second) and included such fine touches as copious teak trim, radio cassette mounted in lockable compartment, integrated swim platform with two ladders and opening side vents in the windscreen. (Some of the teak trim in our test boat is optional. It can be replaced by maintenance-free stainless steel.)

Interior accommodations include a 2-tiered arrangement of V-berth and convertible bench seat bunk, which

TEST PARAMETERS

Each boat was propped and tuned by technicians from Mercury Marine's Mercabo Test base, in Placida, Florida. Speed and timing data are the result of averaging four test runs for each boat with two adults aboard and matched fuel loads. Performance course, which began from a dead stop, included two short sprints and full-speed right, left and 180° turns. All boats ran with 19-in. pitch stainless-steel props. Each had a maximum cuddy headroom of approximately 5 ft. Overall length measurements include integrated swim platforms where applicable.



OVERALL RANKING/MAKE/MODEL

OVERALL RANKING/MAKE/MODEL	1. CELEBRITY 231 SE CUDDY	2. LARSON HAMPTON 220
LOA/Beam/Weight/Fuel Capacity	23'11"/96"/3700 lb./70 gal.	21'11"/102"/3700 lb./50 gal.
Top End (mph)/Ranking	45.12/4, off the pace but adequate	47.5/2, flies like a runabout
Acceleration 0-35 mph (sec.)/Ranking	8.22/1, snaps your head back	9.71/2, leaps up on plane at touch of throttle
Performance Course (sec.)/Ranking	27.70/2, G-force turns made up for sluggish top end	28.48/3, predictable and responsive
Deck Space (sq. ft.)/Ranking	47.48/1, outstanding space for 6 adult passengers	46.36/2, generous, handles a full load comfortably
Cabin Space (cu. ft.)/Ranking	140.17/3, privacy curtain creates two cuddy areas	159.6/1, feels as big as a summer cottage
Stowage Space (cu. ft.)/Ranking	32.82/3, more would be appreciated	57.47/2, substantial, well-layed out compartments
Sleeping Pad (sq. ft.)/Ranking	40.40/2, 2-tiered arrangement increases options	38.42/3, asymmetrical design can fit tall sleepers
Fit And Finish/Ranking	Tasteful teak, strong piano hinges, Eurostyle/2	Marvelous cabin but deck carpeting missed/3
Price As Tested (including Merc engine)	\$26,300	\$26,520
Address	Celebrity Boats, P.O. Box 394, Benton, IL 62812, (618) 439-9444	Larson Boats, Little Falls, MN 56345, (612) 632-5481



Boats equipped with 5.7-liter, 260-hp Mercs.

Steering wheel tilts to 3 positions, but seat mounted uncomfortably close to dash, even when fully adjusted.



Stylish dash panel. Partial sightline obstruction of gauges and instruments that's easy to live with.





CELEBRITY 231 SE CUDDY

can be kept separate from each other by a privacy curtain.

Despite the Celebrity's winning ways, we found a few nits to pick, such as tight quarters at the helm station. A comfortable standing position couldn't be found. The seat is mounted too close to the dash panel and cramps the driver's knees. In fairness, the fully adjustable seat, which couldn't compensate for the problem, affords good legroom and visibility.

Two test-team suggestions could

easily correct some minor shortcomings: 1. Seal the fuses, and 2. Add entry/egress steps. An old-style fuse block left this component exposed to corrosive salt air and moisture. A high freeboard, the result of Eurostyling, makes it somewhat clumsy to get in and out at the dock without climbing over the upholstery.

Overall, the Celebrity scores well across the board, which is essential for any boat designed to be a go-anywhere, do-anything family cruiser.

Larson Hampton 220

At first sight, the test team fell madly in love with the Larson. If looks could kill, the multicolored gelcoat and coordinated interior of the Hampton 220 would be dangerous.

Vaguely reminiscent of a comfortable summer cottage, the Larson leads the fleet in total cabin volume. The living space is populated with a full galley featuring an alcohol stove, ice box and stainless-steel sink. In addition, there's an enclosed head with vanity and an opaque overhead window that lets in enough light to diminish claustrophobia.

On the radar gun, the Larson clocked the second-best top-end speed and recorded second-best times in both hole-shot and performance-course runs. Its patented Delta Conic hull is remarkably responsive in high-speed turns and tracked true in all water conditions and at all throttle settings.

Some outstanding design features include the second-largest deck space, sizable walkaround side-deck and integrated swim platform with a shower spray available at water's edge. Interestingly, the Larson's large cabin features a sharply sloped roof that cuts somewhat into the usable space. Although the entryway measures a full 6 ft. of headroom, it quickly diminishes to the point where unobstructed upright sitting by an average-size adult is impossible. Seating is set back to make room for galley and head.

Another source of concern to the test team is lack of deck carpeting. It's an option on the Hampton and wasn't provided on the test model. Nonskid fiberglass decking is acceptable in a fishing boat, but questionable in a day cruiser.

Nevertheless, the Larson was a fundamentally solid performer and ranked no lower than third in any test category, making it the most consistent boat in the fleet.



3. EBBTIDE 224 CATALINA CUDDY XL

22' 4"/99"/3950 lb./75 gal.

46.56/3, impressive flyer for heaviest boat

10.83/4, swift enough for skiing

28.74/4, not far off a quick pace

36.91/4, some usable area sacrificed for stowage

111.47/4, good layout, headroom, but less volume

68.4/1, immense, but makes deck, cabin seem small

40.85/1, surprisingly large for cabin volume

Best dressed in fleet with traditional marine values/1

\$25,000

Ebbtide, Jones Creek Rd.,
White Bluff, TN 37187, (615) 797-3193

Best sightlines.
Lockable radio
box below
throttle.
Dimmer switch
for panel
lights.



4. COBIA ODYSSEY 230 CXL

21' 10"/96"/3250 lb./67 gal.

48.76/1, sets a blistering pace

10.76/3, change of prop might help, but plenty fast

26.85/1, corners like a roadster

46.06/3, roomy and not far from the leaders

155.92/2, lots of space due to uncluttered approach

32.01/4, less than half the fleet leader

38.04/4, classic V-berth shape, about size of others

Much to recommend, but leanest of fleet/4

\$24,230

Cobia Boat Co.,
Sanford, FL 32772, (800) 327-5703

Small, runabout
style wheel and
good throttle
position. Standard
flat dash has
slight gauge
obstruction.



CUDDY CRUISERS

Ebbtide 224 Catalina Cuddy XL

As with all Ebbtide boats, the Catalina combines familiar marine styling with traditional construction and performance values. There's lots of teak trim, for example, and an old-style rope rub rail. (In saltwater models, some of the teak is replaced by a corrosion-resistant material known as Sansalite.)

Wide walkaround sidedecks make moving from cockpit to foredeck an easy matter for docking or anchoring, and stowage compartments are everywhere, producing a first-place finish in this category. But as a result of these design decisions, the Catalina sacrifices both cabin volume and usable deck space and finished in fourth place in these areas.

Lack of overall cabin volume, however, doesn't prevent Ebbtide from executing a thoughtful interior, which is distinguished by superb headroom due to a trunk-cabin design (raised foredeck), inclusion of hanging garment rack, and the fleet's largest sleeping pad.

While the Ebbtide scores back-of-pack rankings in performance-course times, hole-shot and top-end speed, no noticeable shortcomings are evident and, in fact, it is a smooth-handling, responsive, predictable and uncommonly quiet contender, thanks to a well-insulated engine box.

Features of note include an L-shaped sundeck (formed by raising the stern jump seats and extending the passenger-side sunlounge), teak entry/egress steps and a teak swim platform that's easy on bare feet. All of this, plus upholstery with nicely hidden supports and fastenings, contribute to the Catalina's No. 1 ranking in fit and finish. Fishermen will be delighted with the Catalina's cooler/fish box mounted at the stern.

Do-it-yourself mechanics will appreciate the double-hinged engine cover, which flips up for easy fluid level checks without requiring complete



CELEBRITY
231 SE CUDDY

removal. And boaters, in general, will prize the boat's superb overall craftsmanship and attention to detail.

Cobia Odyssey 230 CXL

The top-performing Odyssey 230 proved to be a driver's favorite with fleet-leading marks in top-end speed and performance-course times, both were out front by significant margins. Hole-shot times weren't too shabby, either, ranking a competitive third. Other strong areas include total cabin volume (second) and usable deck space (third).

Some of the Cobia's blistering speed (nearly 49 mph) can be attributed to lighter load. Its hull is several hundred pounds lighter than the other boats in the fleet. We also suspect the lightweight approach is the reason for the boat's higher decibel reading at cruising speed and slight engine vibration in the deck.

However, the superbly designed hull gets most of the credit for the boat's No. 1 ranking on the performance course. It made up for mid-fleet hole-shot ability through exceptional handling—wheel lock at wide-open-throttle is no problem for the Cobia.

One of the boat's most interesting touches is the use of teak trim only on vertical surfaces (the bulkhead between cabin and cockpit, for instance) a technique used to ensure that UV rays are minimized and water runs off the wood.

Unfortunately, the Cobia has a few shortcomings that held back its fit-and-finish ranking. These include a swim platform that looks like a fiberglass bookshelf, a somewhat difficult through-windscreen access to the foredeck (no walkaround sidedecks) and an engine cover that's a mixed blessing—it permits excellent engine access but requires considerable maneuvering to remove.

Power trip

The test team considered a number of engine options before settling on the MerCruiser 5.7-liter, 260-hp Alpha One sterndrive. We based our choice on the premise that this power package promised enough torque to get the hull quickly on plane and running at sufficient speed to reach a destination without delay.

Equipped with anything less than a small-block V8, boats of this weight would plow through the water with all the grace of a river barge. On the other hand, putting a bulky big-block under the engine box would require a shoehorn and turn the boat into a roaring gas guzzler.

Besides, these pocket cruisers weren't designed to be the fastest boats on the lake. They're family boats made for pure recreational enjoyment—sunlounging, swimming, waterskiing, overnighting and entertaining a minivan's worth of passengers on a warm summer day.

After three days of hard running, we came to realize that the 350-cu.-in., 907-pound Merc was indeed the ideal match. Top-end speed was surprisingly close to 50 mph and hole-shot punch was more than adequate for waterskiing. The engines were relatively quiet, too, ranging from 82 dB to 88 dB at 3000-rpm cruising speed and from 93.5 dB to 94.5 dB at wide-open-throttle.

Paradise, for many of us, is a lazy day on a deserted isle and a boat to take us there. We located the boats—four well-matched (right down to the price) pocket cruisers. It's up to you for the rest.

PM



COBIA ODYSSEY 230 CXL

HOME AND SHOP JOURNAL



WOODWORKING PROJECT

GATELEG TABLE

The classic solution for saving space—a handsome drop-leaf table in solid cherry.

BY ROSARIO CAPOTOSTO,
Contributing Editor

WHILE attitudes change, and styles come and go, there are certain ideas that remain as useful and appropriate today as they were 200 years ago. And, when it comes to furniture, there's little question that the enduring drop-leaf table falls into this category.

Our solid cherry version is based on the Queen Anne style of furniture design popular in the 18th century. When fully open, its spacious circular top easily accommodates up to six people. After your guests have gone, simply fold down the leaves for an elegant side table—and more space in your dining area.

The hinged leaves meet the main top with a beautiful and functional rule joint. While many alternatives exist for supporting the leaves in the open position, we've chosen the classic gateleg design. With the leaves down, the four handsomely carved cabriole legs are positioned at the corners—exactly where they'd be in an ordinary table. However, the legs at two opposing corners actually swing out on traditional wooden hinges when the table is opened.

Color photo: J.R. Rost
Black-and-white photos: Rosario Capotosto
Technical art: Eugene Thompson
Photo stylist: Gabe Herrick

The Tabletop

We used three ¾-in.-thick boards to make each tabletop section. When choosing the stock, try to match the boards for color and grain pattern. Also, plan to join the boards so that the direction of the annual rings on the board ends alternates from one board to the next. This tends to even out any cupping that may occur.

Lay the stock out as it will be assembled and mark the adjacent pieces so they won't be mixed up. Crosscut each piece roughly to length and true all mating surfaces.

While the boards can be glued with no additional joinery, it helps to use dowels or splines to ensure good alignment. We used a plate joiner which cuts accurately positioned slots

for standard, No. 20 compressed-wood plates (biscuits, Photo 1). Make sure to locate the joints so they won't appear on the table edge when the top is cut to shape. Test fit the components before gluing (Photo 2).

To keep the tops flat when they're clamped up, prepare four cauls from scrap stock. These are clamped in pairs above and beneath the assembly at each end. Wrap the cauls in wax paper to keep them from becoming glued to the work.

Apply glue to the mating surfaces of the first section and assemble. Lightly clamp the cauls in place and draw the components together with bar or pipe clamps. Double check that the work is flat and assemble the remaining two sections in the same way.

Use a belt sander to smooth the surfaces (Photo 3). Follow with an orbital finishing sander using 120- and then 220-grit sandpaper. Then, trim the excess from both edges of the center section. Joint these edges and the inner edges of the leaves.

The rule joint is shaped with a router. Use a ½-in.-rad. quarter-round bit for the center-section edges and switch to a ½-in.-rad. cove bit for the inside edges of the leaves. Begin with the center section. Make a trial pass on scrap stock to ensure that the depth of cut will produce the profile shown in the drawing. Note that a strip tacked to the underside of the stock along the edges is required to guide the pilot on the bit (Photo 4). Then, cut the cove halves of the rule



1 We used a plate joiner and No. 20 plates to join the tabletop pieces. Place plates 6 in. apart and locate to miss finished edge.



2 Dry assemble each top section to check for alignment. Apply glue in plate slots and on stock edges. Clamp until glue sets.



3 After the glue has dried, use a belt sander to smooth both sides of each top piece. Finish smoothing with orbital pad sander.



4 Tack strips flush with center section edges to guide ½-in.-dia. quarter-round bit. Cove bit routs rule joint on leaves.



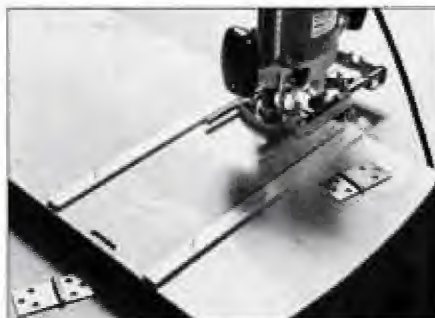
5 Use dual centers, spaced 3 in. apart, to lay out tabletop shape. Block taped to top holds pin end of shopmade compass.



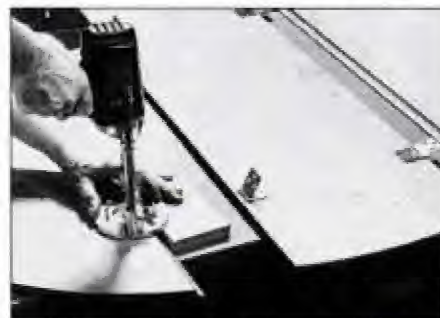
6 After the curve is drawn, band saw top sections to the line. Then, smooth with stationary belt sander or by hand sanding.



7 Clamp top together with C-clamps and long boards that span joints. Rout edge profile with ½-in.-dia. quarter-round bit.



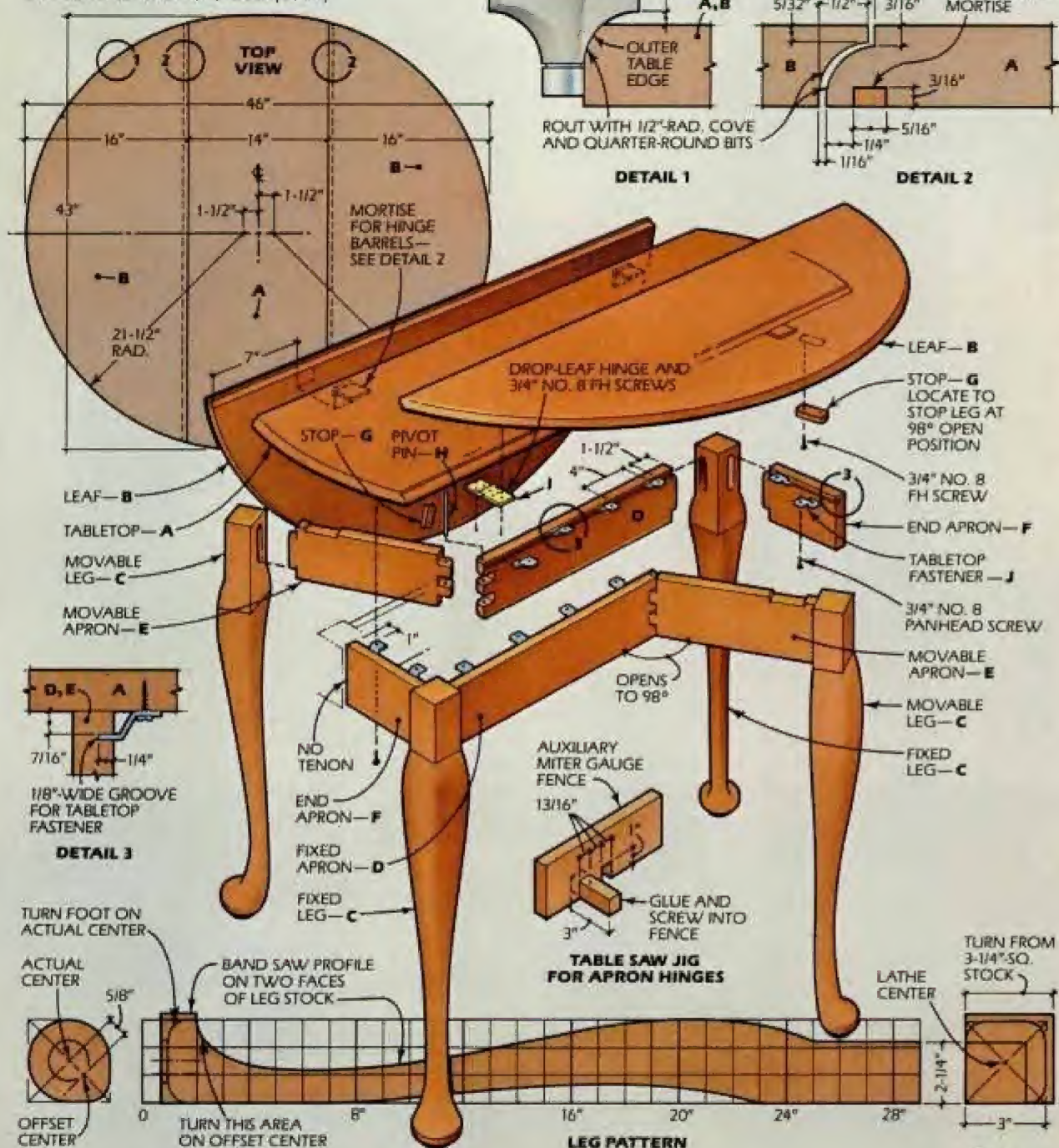
8 Rout mortises in center section for drop-leaf hinge knuckles. Router edge guide and strips tacked to stock guide cut.



9 Mark hinge screw hole positions and bore screw pilot holes to correct depth. Drill guide ensures perpendicular holes.

GATELEG TABLE

29" HIGH X 43" WIDE X 46" DEEP (OPEN)



MATERIALS LIST—GATELEG TABLE

Key	No.	Size and description (use)
A	1	1/2 x 15 x 43" cherry (top)
B	2	1/2 x 16 x 43" cherry (leaf)
C	4	3/4 x 3 3/4 x 28 3/4" cherry (leg)
D	2	1/2 x 4 x 19 1/2" cherry (fixed apron)
E	2	1/2 x 4 x 13" cherry (movable apron)
F	2	1/2 x 4 x 7 1/2" cherry (end apron)
G	2	1/2 x 1/4 x 2 1/2" cherry (stop)
H	2	1/2" dia. x 3 3/4" steel pin (pivot)
I*	2 pr.	1 1/2 x 3 3/4" drop-leaf hinge
J*	12	1/2 x 1 1/4" tabletop fastener
Misc.		3/8" No. 8 fh screws (24 reqd.), 3/4" No. 8 panhead screws (12 reqd.), 1/4" No. 8 fh screws (4 reqd.), 120- and 220-grit sandpaper, Behlen's Virginia Cherry Gel Stain, Minwax Semi Gloss Polyurethane Varnish.
		* Hinges (No. 810) and fasteners (No. 77001) available from Armor Products, Box 445, East Northport, NY 11731.

joint on the leaves.

The shape of the tabletop is not a true circle, but rather two half circles set 3 in. apart. First prepare a strip of wood to act as a compass. Install a push pin or nail at one end and bore a small hole for your pencil 21½ in. away. Lay out the tabletop pieces and tape a small block of wood at the center to receive the point of the compass

(Photo 5). After drawing each circular half, connect the lines using a flexible stick bent tangent to the arcs as a guide for your pencil.

Band saw to the line (Photo 6) and sand the edges smooth. Clamp the pieces together and to your workbench for routing the edge profile with a ½-in.-rad. quarter-round bit as shown (Photo 7).

To install the drop-leaf hinges, first rout the hinge knuckle mortises on the underside of the center section as shown (Photo 8). Then, clamp the pieces together—top side up—with ¼-in.-thick spacers in between the sections. Flip the assembly over, position the hinges and mark and bore the screw pilot holes. Then, install the hinges (Photo 9).

Shaping The Legs

The legs are made from square 16/4 (4x4) stock. You can also glue together thinner boards to produce the leg blanks. Joint each piece to 3¼ in. sq. and cut them to finished length. Then, make two band saw cuts on the top of each leg to form the recessed cheek surfaces (Photo 10). These cuts are placed 1 in. in from adjacent faces and extend 4 in. deep, as shown.

Then, cut the 1⅜-in.-deep mortises for joining the aprons. Note that two legs have a mortise on each inner face and the other two have only one mortise apiece. The legs with only one mortise are the pivoting legs—be sure to lay out the mortise on the same face on each.

The mortises can be cut with a router equipped with an edge guide and ¾-in.-dia. straight bit. However, preboring a series of ½-in.-dia. holes makes the job easier and saves wear

and tear on the bit. The mortise ends are left round and the tenons will be shaped to fit (Photo 11).

The next step is to band saw the leg profile on the same two adjacent faces where you made the 4-in.-deep cheek cuts. Using a template made from cardboard, lay out the curves on the stock. Before making the cuts, however, mark the true center of the blank on each end and the offset center at the foot end as shown in the drawing. Note that the foot profile is not sawn but left square.

Band saw the profile on one face of the first leg. Tape the waste back in place to provide support for cutting the adjacent side and to restore the cutting line. Then, make the second profile cut and shape the remaining legs in the same way (Photo 12).

Sand the cheek surfaces and the convex knee area of each leg. Mount a leg in the lathe on its true centers for

turning the foot. Run the lathe at slow speed and turn the foot profile as shown in the drawing (Photo 13). Also, shape the convex, back ankle area just above the foot.

After sanding at medium speed, shift the tailstock center to the offset center of the leg foot as shown in the drawing and shape the concave section just above the foot at slow speed. Take very light shavings and check the work frequently to avoid removing too much wood (Photo 14).

During all the turning operations, be very careful to keep your hands clear of the rotating leg. Most of the leg is eccentric and its corners are indistinct and difficult to see.

After the foot area has been turned, lock the leg in position using the indexing pin on the lathe and shape the remaining sections with rasps, files and spokeshave (Photo 15). Then, sand the leg smooth.



10 Band saw 4-in.-deep cuts, 1 in. from the surface of 3¼-in.-sq. leg blanks. These cuts form leg cheeks on adjacent sides.



11 Rout mortises 1⅜ in. deep. Preboring ½-in. holes makes job easier. Note two swinging legs have only one mortise each.



12 Lay out profile on two sides of stock and band saw one face to line. Reattach waste with tape, band saw adjacent face.



13 Mount leg in lathe on actual stock centers. Turn convex foot section to profile shown. Also, begin to round back of ankle.



14 Turn inside concave area above foot on offset center. Use round-nose turning tool. Stay safely away from knee area.



15 Do final shaping with spokeshaves, rasps, files. Use index pin on lathe head to keep leg in place. Smooth by hand sanding.

Apron Joinery

First cut the stock to width and oversize in length. Mount a dado blade in the table saw and set for a $\frac{13}{16}$ -in.-wide, 1-in.-deep cut. Prepare a 4 x 12-in. auxiliary miter gauge fence and cut two notches in it exactly $\frac{13}{16}$ in. apart. Glue and screw a guide pin to the outer most notch as shown in the drawing. Then secure the assembly to the miter gauge so the remaining notch lines up with the dado blade.

Place a fixed (long) apron against the fence with its face out and its edge against the guide pin. Cut a notch in the apron end (Photo 16). Without removing this piece, place a pivoting (short) apron against the first piece—face in—so its edge lines up with the outer edge of the last notch. Clamp both pieces to the fence and make the cut (Photo 17). Shift both pieces over the guide pin for the second cut (Photo 18). Repeat the procedure for the third cut.

Engage each knuckle joint and bore a $\frac{1}{4}$ -in.-dia. hinge pinhole from the top edge that stops $\frac{1}{4}$ in. from the bottom. Bore the last $\frac{1}{4}$ in. with a $\frac{1}{8}$ -in. bit. This keeps the pin in place, but allows it to be driven out when necessary. Round the corners of the hinge fingers as shown.

With the pins installed, mark the apron lengths and cut to size. Prepare

the end aprons and cut all tenons with the dado blade. Then round the tenon ends to match the mortises. This can be done by hand, or you can use a template and guide bushing with your

router (Photo 19). Cut a groove in each apron piece for the tabletop fasteners and notch the movable aprons so they clear the drop-leaf hinges as shown in the drawing.



16 Cut wooden hinges with dado blade and auxiliary miter gauge fence. Begin by cutting 1-in.-deep notch in long apron.



18 Shift aprons over the guide pin, clamp and cut. Third pass requires scrap block behind top apron to prevent tearout.



17 Clamp short apron to long apron and fence. Align edge of second piece with outer edge of first notch and make the cut.



19 Use a template and a router with guide bushing to round edges of tenons to fit routed mortises. Or round tenons by hand.

Assembly And Finish

Gluing the aprons to the legs is done in two stages. First, dry assemble the long hinged aprons to the appropriate legs. Lay these subassemblies upside down and in position on the inverted top. Place wax paper between the top and legs. These subassemblies hold the legs in position for gluing and clamping the short end aprons. Apply glue to the end mortise-and-tenon joints and draw the joints tight with bar or pipe clamps. Check for square and adjust if necessary. (Photo 20).

After the glue has dried, remove

the clamps and apply glue to the long apron mortise-and-tenon joints. Use C-clamps and scrap stock to hold the hinged aprons rigid and straight. Then, draw the joints tight with pipe clamps, check for square and let the glue set (Photo 21). Finish sand all the components with 220-grit sandpaper.

It's easiest to finish the table before installing the top and with the hinged aprons and leaves disassembled. We used Behlen's Virginia Cherry gel stain followed by three coats of Minwax Semi Gloss Polyurethane varnish. When choosing a stain, keep in

mind that cherry will darken naturally over time. Sand lightly between each coat of varnish.

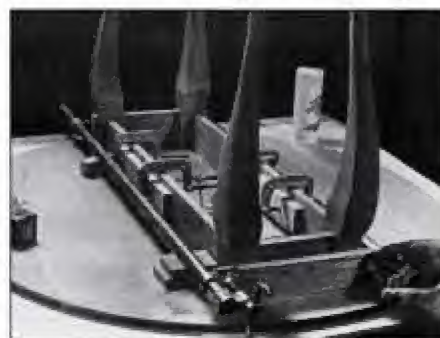
The bottom surface of the center top section need not be stained. However, it's a good idea to apply the same number of coats to both surfaces of every piece to help prevent warping.

Finally, reassemble the tabletop and hinged aprons. Lay the base subassemblies in position on the inverted top and install the tabletop fasteners (Photo 22). Then, screw in place the two small blocks that limit the travel of the swinging legs.

PM



20 Begin assembly by dry fitting long aprons to legs for support. Then, glue and clamp short aprons to legs and let glue dry.



21 Use scrap stock clamped alongside aprons to hold hinges straight. Apply glue and draw remaining joints tight.



22 After applying finish, secure tabletop to base assemblies with metal fasteners. Prebore screwholes to correct depth.



PM PLANS

GARAGE GETAWAY

A spacious 2-car garage with a studio and loft above.

BY WILLIAM and DIANE WINANS

EVEN THE most mundane garage does more than house the family car—at least it's *expected* to do more. It's the repository for all of your gardening tools, power equipment and, just about everything else

that you simply don't know where to put. And, when the time comes to overhaul the carburetor or build a set of shelves, the humble garage is once again called on for the job. However, we're about to show you that garages needn't be humble.

We've designed this spacious 28-ft.-wide garage to fill all the above needs—and do the job with style and grace. Along with a standard 8-ft.-wide garage door, we've added a 10-ft.-wide door—large enough for a camper or wide-bodied boat. At 22 ft. deep, you've enough space left over for all your outdoor equipment. There's even a niche for your workbench under the front window.

If your enthusiasm for a complete workshop takes priority, you could easily devote up to 280 sq. ft. for your tools and machinery, and still have plenty of room available to park your automobile.

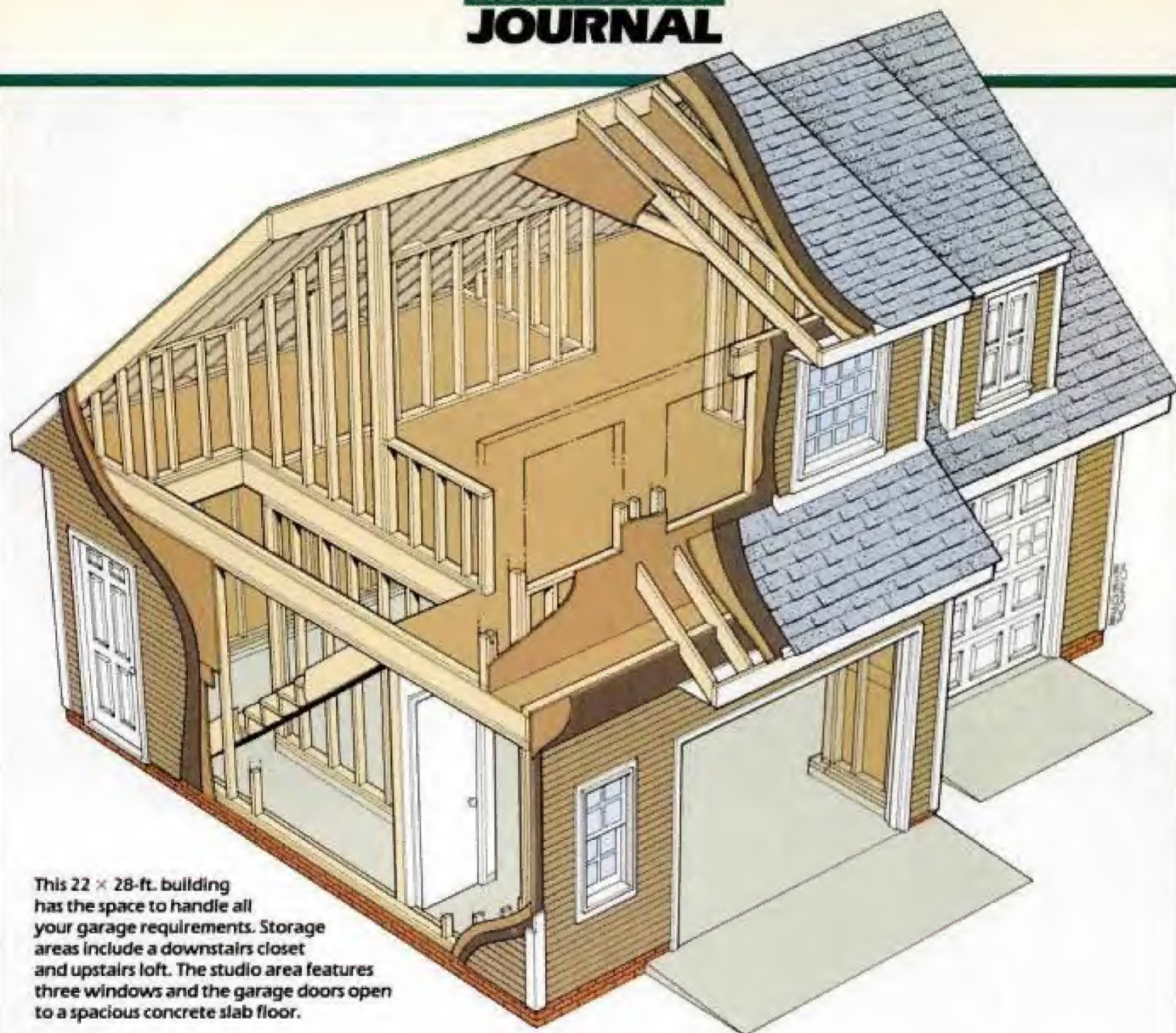
But what really makes this garage special is the second floor. On one

side, we've designed an ideal studio area—perfect for craft or art activities. It might also serve as an office, planning center or finishing room for a woodworking shop downstairs. With

Source List

- **Mastic T-lok vinyl siding and accessories:** Mastic Information Center, Box 213, Dept. PM, St. Joseph, MI 49085-0213
- **Summit III roof shingles:** Georgia Pacific Corp., 133 Peachtree St., N.E., Box 105605, Atlanta, GA 30348
- **Cierra clad windows:** Louisiana Pacific Corp., Weather Seal Div., 324 Wooster Rd., Barberton, OH 44203
- **Inner-Seal structural panels:** Louisiana Pacific Corp., 111 S.W. 5th Ave., Portland, OR 97204
- **Steel garage doors:** Stanley Door Systems, 1225 E. Maple Rd., Troy, MI 48064
- **Woodgrain Pegboard paneling:** Masonite Corp., 1 S. Wacker Dr., Chicago, IL 60605
- **Exterior lighting:** Dinico Products, Inc., 123 S. Newman St., Hackensack, NJ 07601
- **John Deere equipment:** John Deere Horicon Works, Horicon, WI 53032
- **Garden tools:** True Temper Hardware Div., Box 3540, 465 Railroad Ave., Shiremanstown, PA 17011

Color photos: Design Photography
Technical art: Eugene Thompson



This 22 × 28-ft. building has the space to handle all your garage requirements. Storage areas include a downstairs closet and upstairs loft. The studio area features three windows and the garage doors open to a spacious concrete slab floor.

a few modifications, it could even be outfitted as a small apartment or guest room.

We've dedicated the space above the smaller bay to anything and everything that you might need to store. This loft area features a shed-style dormer with double doors for convenient access.

The garage features stout wood-frame construction with 2x4 studs, 2x10 joists and 2x6 rafters—all on 16-in. centers. The framework is sheathed with Inner-Seal Structural Panel and the first floor is a solid, 4-in.-thick concrete slab. To achieve the uninterrupted space downstairs and provide support for the second story, we've spanned the midsection of the building with a heavy-duty wide-flange steel beam.

Although you could finish your garage with one of several traditional sidings such as shakes, wooden shingles or clapboard, we used Mastec T-lok siding and accessories for fast

installation and years of maintenance-free good looks.

Because the building is so easily modified, you might simply use our plans as a starting point and custom-



Overhead steel garage doors and steel-clad side-entry door seal out the weather. Dormer doors offer alternate access to the storage loft.



ize the space to suit your personal requirements. The construction is well within the range of most experienced do-it-yourselfers. Although material costs can vary, you should be able to construct the entire garage for not much more than \$6500 if you do all the work yourself.

However, it may make sense to hire professionals for some of the more specialized tasks such as laying the foundation and installing the vinyl siding.

PM

How To Order Plans

Plans for PM's 2-bay garage consist of four 17 × 22-in. drawing sheets, a detailed 8-page instruction manual, and a complete materials list. A single set of plans costs \$18.50. If you need another set of plans to file for a building permit or to give to a contractor, each additional set will cost \$16 when purchased with the first set. Send your check or money order to 2-Bay Garage, POPULAR MECHANICS, Box 1014, Radio City Station, New York, NY 10101.

SHOP TECHNIQUES

SAW BLADE SHARPENING

TEXT AND PHOTOS
BY ROSARIO CAPOTOSTO,
Contributing Editor

THE USE OF a sharp circular saw blade is essential for clean and fast cutting as well as for operator safety. A dull blade leads to forcing the work through the cut which can result in binding and dangerous kick-back and can also overload the motor. Add to this the probability of scorched edges on your stock, and it's a much better idea to work with a sharp blade.

Sometimes it's best to have a blade sharpened commercially, especially if it's old and extremely dull. But you can do routine sharpening yourself to save time and money. The job is not difficult but it does require precision filing which can be mastered with a little practice. Do keep in mind, however, that what follows does not apply to carbide-tipped blades. These must be sharpened by a specialist.

Frequently, cleaning and a quick touchup filing may be all that's required to make a blade perform like new. But if hard use and abuse have caused the teeth to wear unevenly, lose their set or become misshapen due to repeated filing, the blade may need to be reconditioned by some or all of the following operations:

■ **Jointing** is done to bring the point of every tooth to precisely the same distance from the center of the blade.

■ **Shaping** restores the contour of the teeth which have become flattened at the top after jointing. It also



sometimes involves deepening rounded gullets to a new depth when major reshaping is necessary.

■ **Setting** is the alternate bending of the teeth tips to the right and left so they will cut a kerf wider than the body thickness of the blade.

■ **Filing** is the final step. It actually sharpens the bevels or points of the teeth. As stated earlier, this is sometimes the only step required.

Before you begin any mechanical operations clean the blade to remove deposits of gum and pitch.

Jointing

Jointing is done by mounting the blade on the table saw in the reverse

position so the teeth point backward. Lower the arbor so the blade is below the table and not touching an oilstone which is held firmly over it. Wear protective goggles or a face mask for this operation.

Start the motor, then *very slowly* and carefully raise the blade so it just barely touches the stone. Stop the motor and check your progress often. Continue until a tiny flat section appears on the tip of each tooth.

If the blade has raker teeth—these are straight teeth that have no set and are found on some combination blades—they must be filed down individually so they will be about $\frac{1}{64}$ in. shorter than the cutting teeth.



1 Fantastik household cleaner is very effective for removing deposits of gum and pitch. Spray it on, let the blade soak for 10 minutes, then rinse blade with hot water.



2 For jointing, first reverse blade on arbor. Hold oilstone firmly over table slot, then raise lowered blade slowly until it just touches. Be sure to wear eye protection.



3 Draw a reference mark on the blade below gullets to guide the filing depth when blade needs reshaping. Hold pencil against the blade and turn the blade by hand.

To do this, block the blade with a piece of scrap wood in the table saw so it won't move. Then support the file on a block of wood and slide it along the tabletop to file the rakers. Count the file strokes so all the rakers will be the same height.

Shaping

If the blade is to receive major reshaping, a filing reference circle should be marked below the gullets. Do this by holding a pencil against the blade while rotating it by hand.

For any filing operation, the blade must be held firmly in a suitable clamp, like the one shown, which is in turn held in a vise. (To build our clamp, see the drawing on page 88.)

Circular saw blade teeth sizes vary considerably so no specific file size can be given here. In general, one of these files will do for crosscut teeth: 4- to 8-in. slim taper, extra-slim taper, or double-extra-slim taper, to suit the tooth size.

For some combination saw blade teeth, which have very steep-face rake angles, a 6- to 8-in. cantsaw file must be used. For all other teeth use a

6- to 8-in. smooth mill file and use a round file for the gullets.

File straight across (no beveling) until the jointing flats disappear and the teeth have received their correct outline shapes.

Setting

Setting may be done with a special setting tool or you can use a home-made setter like the one shown. (To build one, follow the drawing on page 88.) It utilizes a bolt, with a 10° bevel filed on its head, as an anvil. Place the tooth on the anvil then strike the point with a drift punch to form the bend. Do all the teeth which are set in one direction, then reverse the blade and set the remaining teeth. Raker teeth are *never* set. Nor are the teeth on hollow ground blades.

Filing

Secure the blade in the clamp and sharpen the teeth with the same files used for shaping. File the teeth as close as possible to their original configuration until a sharp point is obtained. Avoid filing sharp corners into the bottoms of the gullets because

they can develop into fractures. File all the teeth that are set away from you then reverse the blade in the clamp and file the remaining teeth.

File rip saw teeth straight across to form a chisel-like edge. If reshaping is not required, file only the tops of the teeth. Crosscut teeth are filed at a bevel angle on the front and back slopes to produce knife-like edges. On some blades, these front and back bevel angles differ so they must be filed separately. But others are shaped so a taper file will cut the front bevel of one tooth and the back bevel of an adjacent tooth simultaneously.

Similar filing procedures are used for filing combination blades. The raker teeth (on those blades that have them) are filed straight across. The rakers should end up between $\frac{1}{64}$ - to $\frac{1}{32}$ -in. lower than the cutting teeth. On the cutting teeth, the file is stroked straight across or at a bevel angle, as required.

Keep in mind that your goal is to file the teeth on the specific blade to their original angle and shape. So be sure to carefully inspect the blade before you start working.



4 Secure shopmade clamp in bench vise. Clamp grips the blade close to the teeth to prevent chattering. This version is suitable for blades that are from 4 to 12 in. dia.



5 To deepen gullets, rotate the round file slightly as it is stroked forward. Do not rock the file and be sure to use the same number of smooth, even strokes per gullet.



6 File the faces of rip teeth only when reshaping is required. A mill file with one round—or ground-off—edge facing down should be stroked straight across.



7 Set blade after shaping but before sharpening the teeth. Place tooth on beveled bolt-head anvil, then strike with drift punch to bend only the tip of the tooth.



8 File the tops of rip saw teeth straight across until the flats resulting from jointing just vanish. The original top bevel clearance angle must be maintained.



9 File crosscut teeth until one-half the jointing flat disappears. Then reverse the blade in clamp and file the alternate teeth to remove the remainder of each flat.

Building the clamp and anvil

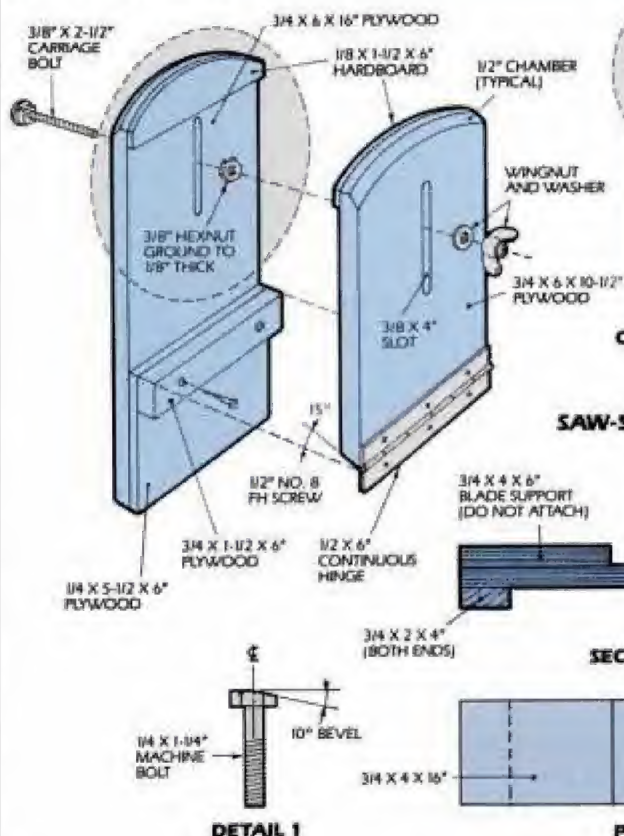
These two easy-to-build fixtures will make short work of sharpening just about any blade. They are both sized to accept blade diameters from 4 to 12 in. To build the clamp, begin by cutting the parts to size and shape using a jigsaw. Then cut the bolt slots in both halves.

Glue and clamp the rest of the parts in place, then join the halves by installing the continuous hinge, and you're done. Simply insert the blade between the halves, tighten it with the carriage bolt and hold the entire jig in a bench vise.

The saw-setting anvil is even easier to build. Just cut the base to size and cut the appropriate slot. Then cut and glue in place the small-block feet on each end. Cut the blade support block to size but don't attach it to the base. Insert and tighten the larger bolt in the slot, then bore a hole for the anvil bolt. Test fit this smaller bolt so the top of the head is exactly $\frac{3}{4}$ in. above the base, then remove the bolt and grind off one side of the head at a 10° bevel. Push the bolt back in the hole, insert your saw blade and set the teeth as shown in the photo on the previous page.

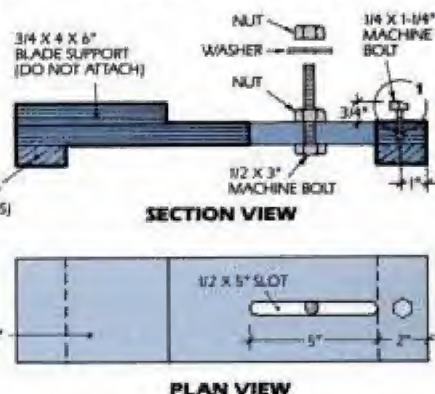
FM

SAW-FILING CLAMP



CLAMP END VIEW

SAW-SETTING ANVIL



SECTION VIEW

PLAN VIEW

DETAIL 1

BOOK REVIEW

DO-IT-YOURSELFERS have an insatiable appetite for helpful information when tackling woodworking and home-remodeling projects. For the past couple of years, there have been two books that I've consulted time after time. Both are written by John Feirer who's a respected woodworking expert, author and former department head at Western Michigan University. (The carpentry book was co-authored with Gilbert Hutchings who was a professor at WMU.)

The first book, *Furniture & Cabinet Making* (\$22.50), covers every aspect of furniture building from a brief history of cabinetmaking and furniture design; through cutting joints, basic construction and assembly; to the secrets of applying a professional finish.

The 512-page, 61-chapter softcover book is divided into five sections: Introduction, Materials and Layouts, Tools and Machines, Construction, and Finishing. Hundreds of black-and-white photos and detailed drawings help the reader throughout the book.

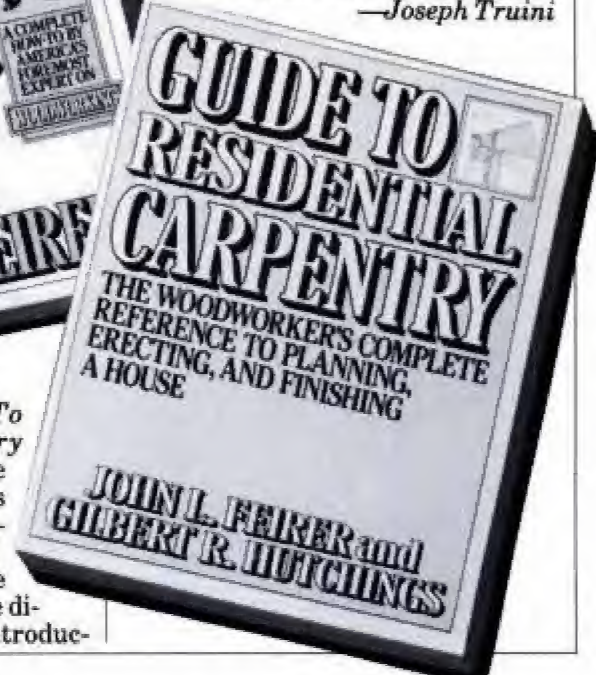


The second book, *Guide To Residential Carpentry* (\$19.95), would be a valuable addition to any homeowner's library. This 477-page softcover book explains typical house construction from the ground up. Its 36 chapters are divided into seven sections: Introduc-

tion; Materials, Tools, Machines and Equipment; Foundations; Framing; The Exterior; The Interior; and Methods for Conserving Energy.

Look for these books at a local bookstore or write to Macmillan located at Front and Brown streets, Riverside, NJ 08075.

—Joseph Truini



TOOL TEST NO-HOLES HANGER

TEXT AND PHOTOS
BY ROSARIO CAPOTOSTO,
Contributing Editor

A UNIQUE method for installing hooks to household surfaces—without nails or screws—has been introduced by Sears. Called the Hang Fast, this system makes use of adhesive-backed plastic discs that are applied directly to the walls by means of a simple electric applicator. The applicator has a heating element that softens the adhesive to the adhesion temperature.

Once the discs are in place, simply slide a hook over the top and you can hang anything that weighs up to 25 pounds on the wall. We tried the discs on painted and papered walls, wood, ceramic tile and plastic laminate. Each held up, without trouble, under our test load of 25 pounds.

Though application is convenient, the best feature of this system is that the discs can be removed without damaging the wall. You just have to take off the hook and reheat the disc with the applicator. This softens the adhesive again so the disc can be pulled right off.

The Hang Fast applicator (No. 80481) comes with four mounting discs and costs \$11.67 at Sears stores nationwide. Extra discs costs \$1.93 for a 10 pack and the hooks cost about \$1 apiece. For more details, contact Sears, Sears Tower, Dept. 703-PM, Chicago, IL 60684. **PM**



Slide adhesive-backed plastic disc onto heating element on the end of the electric applicator. Heat softens adhesive so the disc will bond to the wall's surface.

Hang Fast system includes electric applicator and four adhesive-backed discs. Slide-on hooks, sold separately, can hold picture frames, clothing and towels.



Manufacturer claims discs can hold up to 25 pounds, which was verified by our simple load test. None of the tested discs moved.



Position disc on wall surface and hold steadily in place for 5 to 15 seconds. Time varies depending on the type of wall surface.



Allow adhesive on back of disc to cool for a few seconds. Then slide hook over disc. All hook types fit over standard disc.



GROUND ATTACK.

DODGE RAM PICKUPS.

Dodge will take you by storm. Leading the charge is fuel-injection on every engine we make, even our monster 360 V-8. And behind it all is up to 5,500 lbs. of available payload and our exclusive 7 year or 70,000 mile Protection Plan.* We've even added new anti-lock rear brakes. 1989 Dodge Pickups. Hot on your trail. **7/70**

*See this powertrain limited warranty & its restrictions at dealer.



**THE TOUGH NEW
SPIRIT OF DODGE**
THE PERFORMANCE DIVISION OF CHRYSLER MOTORS

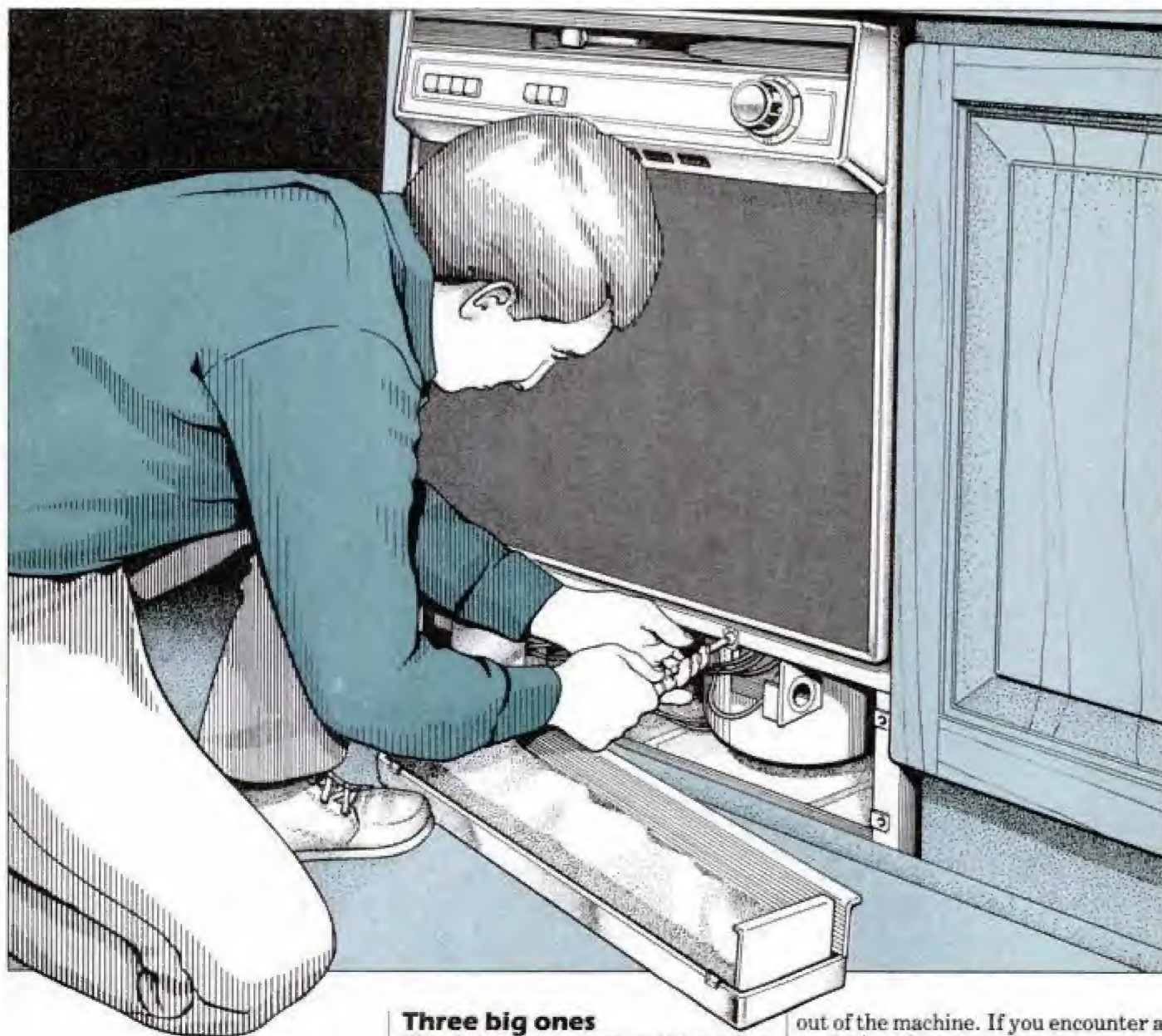


BUCKLE UP FOR SAFETY.

Копировать, заимствовать, распространять запрещено.

How To Repair A DISHWASHER

BY MORT SCHULTZ; PM Illustrations by George Retseck



LOOKS are often deceiving. Take a built-in dishwasher. When a breakdown occurs, you may think you have to unbolt the unit and pull it out from under the counter. But in reality, there are only two failures, rare ones at that, that may require this much trouble. You can probably fix every other failure yourself with comparative ease.

Three big ones

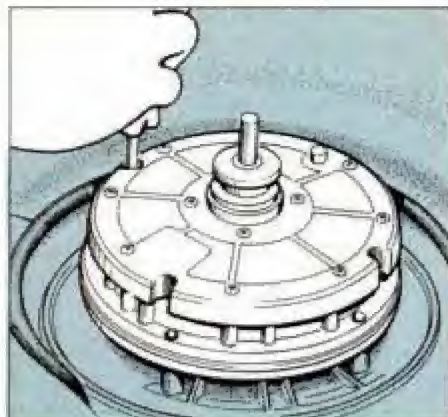
The three most common dishwasher repairs are a leaking pump, lack of water fill into the dishwasher, and failure of water to drain properly.

Although all dishwashers work similarly, there are some differences in components from model to model. For example, most models have drain valves. Some don't. Those without drain valves have motors that reverse direction of rotation to pump water

out of the machine. If you encounter a variation that stumps you, you can get help at an appliance parts store. In addition to the advice that counter personnel can provide, parts stores sell do-it-yourself repair manuals that are published by appliance manufacturers.

Leaking pump

Don't dismiss a trace of water on the floor as a minor leak: It could be a sign



1 To gain access to pump, begin by removing spray arm. Then unscrew top of the wash cycle pump housing. Set screws aside.

that the motor is about to be ruined. To check this out, unscrew the bottom access panel and see if there is water under the pump. If there is, check to see if the water inlet or drain hose has split, or if the overfill switch has failed. If these all look fine, then you'll have to replace the seals in the pump, especially if the pump and motor are an integrated assembly, as they are in most dishwashers.

The pump sits on top of and is driven by the motor. A damaged seal, therefore, may allow water to seep in and short out the motor. Instead of \$10 or \$15 for a kit containing new seals, you could end up spending over \$200 for a new motor if a bad seal isn't replaced quickly. You can buy a seal kit for your model from an appliance parts store. Before you begin to work, turn off the water and the power to the dishwasher at the circuit breaker or fuse box.

To begin the task, open the door, remove the bottom rack, and pull off the lower spray arm. If the lower spray arm is held in place by a cap, un-



2 Lift off the top of the housing and set it aside. With top off, the wash cycle impeller is exposed. Check impeller for cracks.

screw the cap. In many models, including the dishwasher illustrated here, there are two filters. They are a coarse strainer for catching large particles and a self-cleaning fine-mesh strainer to catch smaller particles. Remove both.

From here on, there are quite a number of parts and screws that have to be removed before reaching the seals. As you take them off, lay out the parts in order. Keep their fasteners with them. Doing so will help you avoid misplacing a component and will make reassembly easier.

Two-pump system

The pump in most dishwashers is actually two pumps in one. One, the wash cycle pump, circulates water to the lower and upper spray arms during the washing cycle. The second, the drain cycle pump, pumps water from the dishwasher at the end of the washing cycle.

To get at the seals (in the Kitchen-Aid unit illustrated here, there are three seals that have to be replaced),



3 Remove screw that holds impeller in place. Then lift impeller off pump shaft and set it aside so it won't be damaged.

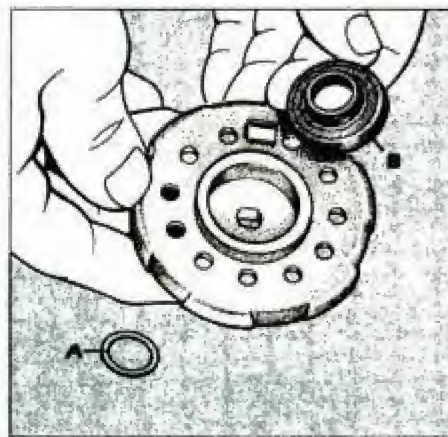
unscrew and remove the top of the wash cycle pump housing (Figs. 1 & 2). Then, unscrew and remove the wash cycle impeller (Figs. 3 & 4).

Be sure to inspect the wash cycle impeller for damage. If you are ever faced with a problem of dishes not coming clean and have checked on the most likely reasons—water temperature not being hot enough, dishwasher detergent that has been stored too long and has lost potency, and improper stacking of dishes—a cracked wash cycle impeller should be next on the list of possible causes.

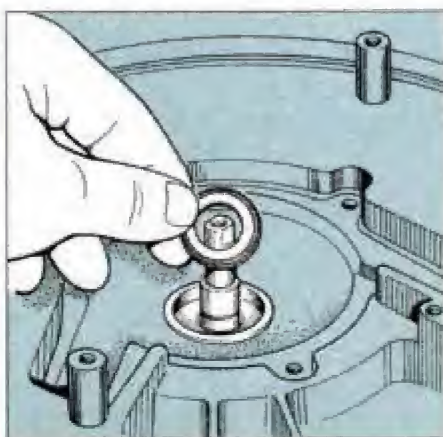
To continue disassembly, lift off the bottom of the wash cycle pump and unscrew the part under it, which performs two jobs. It serves as a seat for the self-cleaning fine-mesh strainer, and it separates the wash cycle pump from the drain cycle pump (Fig. 5).

Sealing the pump

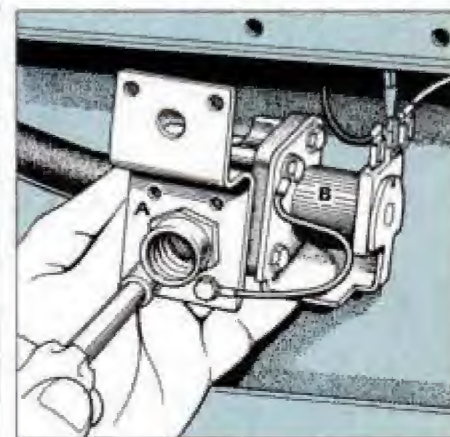
Note: The procedure outlined here will help guide you in resealing a pump. The seals in your pump may not be positioned exactly as they are



7 In addition to an O-ring (A) that goes around the motor shaft, this impeller has a rubberized seal (B) that must be replaced.



8 The third seal that must be replaced is a ceramic seal at the bottom of the pump housing. Press the new seal in place by hand.



9 Water-inlet valve consists of valve (A) and solenoid (B). To check the filter inside the valve, remove the mounting bolts.



4 As you remove each part, make sure to check exactly how it was installed so that your reassembly later will be mistake free.

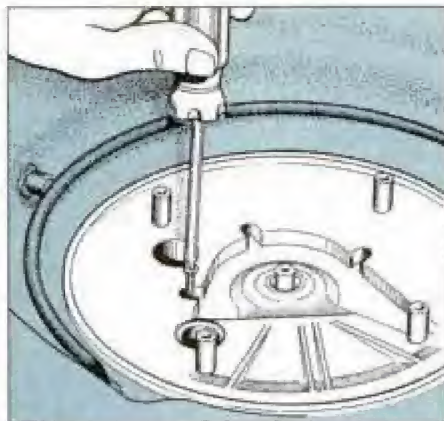
in the pump shown here.

The seals are located in the drain cycle pump housing. To reach them, pry the drain cycle impeller off the motor shaft (Fig. 6). Do this gently to avoid damaging the part. When this has been done, the three seals which have to be replaced can be removed.

To differentiate between these three seals, let's refer to them as a ceramic seal, a rubberized seal and an O-ring. The ceramic seal is pressed into the pump housing cavity on which the drain cycle impeller sits. The rubberized seal is positioned in the hollow on the bottom of the drain cycle impeller (Fig. 7). The O-ring is positioned around the motor shaft inside the top of the drain cycle impeller.

As the drain cycle impeller is removed, the rubberized seal and O-ring can be picked up with your fingers. Use a small screwdriver to pry the ceramic seal from the drain pump housing cavity (Fig. 8). Don't let the screwdriver slip and damage the pump housing or motor shaft.

To complete the resealing opera-



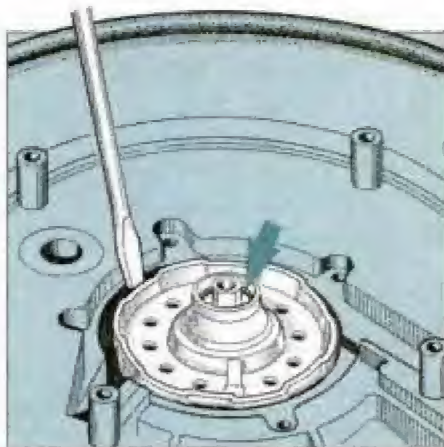
5 Next, unscrew the plate that separates the wash cycle and drain cycle pumps. Then lift it off to expose the drain cycle impeller.

tion, dip the new ceramic seal in water and press it into the drain pump housing cavity with your fingers. Push the new rubberized seal into the hollow on the bottom of the impeller and reinstall the impeller. Then, install the new O-ring around the motor shaft, pressing it securely into place.

Faulty water fill

If you have insufficient supply or a complete lack of water going into the dishwasher, the most likely reasons for this are an open circuit in the water-inlet valve solenoid, a bad overflow switch, and a faulty timer.

Work on the water-inlet valve solenoid first. Begin by unscrewing the bottom access panel. The water-inlet valve with the attached solenoid will be in plain view (Fig. 9). In many dishwashers, the water-inlet valve is held by a bracket that is bolted to the chassis. Disconnect the water supply line from the valve. Remove the clamp from the hose on the valve outlet and pull off the hose. Unscrew the bracket from the chassis and disconnect the



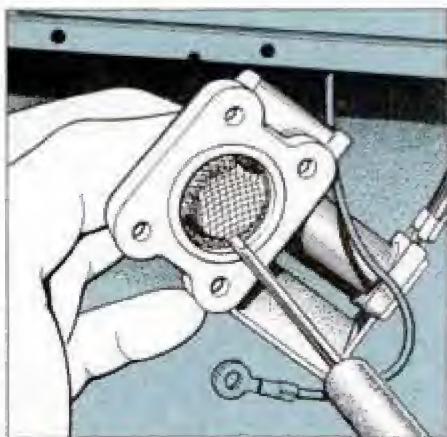
6 Carefully pry drain cycle impeller out of pump housing using a flat-blade screwdriver. Note the O-ring location (arrow).

pull-off, push-on electrical connectors from the solenoid terminals. **Important:** As you remove each connector, label it to identify to which terminal it connects. Wires must be reconnected to their respective terminals.

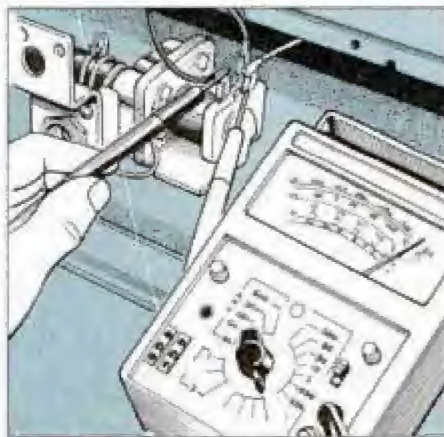
See if there's a little cone-shaped, metal filter screen inside the valve intake nozzle. If this filter clogs, the amount of water needed by the dishwasher to get dishes clean will be reduced or cut off altogether. Pry the screen out of the nozzle and wash it under a water faucet using a toothbrush to remove particles (Fig. 10). A mild acidic solution, such as vinegar, helps to clean stubborn particles from the screen.

Testing the solenoid

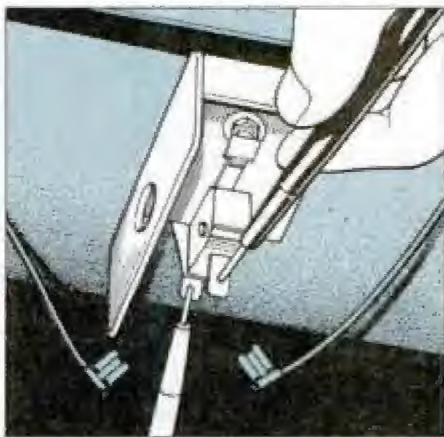
Set an ohmmeter on the $R \times 100$ scale and attach the leads of the meter to the terminals of the solenoid to check continuity (Fig. 11). A reading between 500 and 2000 ohms indicates that the solenoid is operating properly. However, if the ohmmeter shows a reading of infinity, the solenoid is bad.



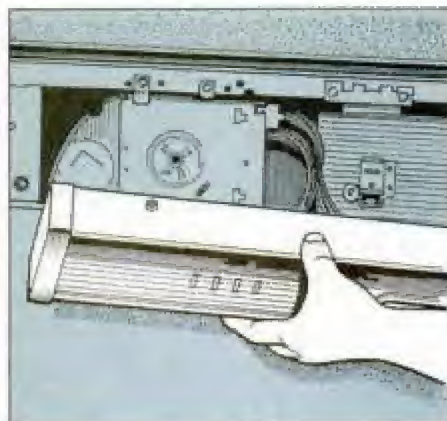
10 Carefully remove the filter screen from the valve by prying with a small screwdriver. Gently brush any debris from the screen.



11 To check continuity of solenoid, turn off power, then set ohmmeter to the $R \times 100$ scale and touch probes to terminals.



12 Also check the continuity of the overflow switch by holding the probes of an ohmmeter to the wire terminals on the switch.



13 To get inside console where the timer is located, unscrew console panel. Then carefully pull it away and let it dangle.

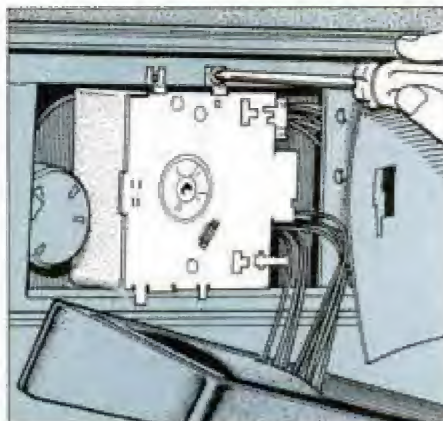
A solenoid winding opens when it's warm and closes when cold, because the winding expands and contracts according to temperature. The valve, therefore, may operate on one occasion, but not on another. Therefore, a continuity test made when a valve is cold could indicate that it's okay when it isn't.

Do another test, after running hot water over the solenoid for a few minutes. If you get an acceptable ohmmeter reading, then chances are the lack of water going into the dishwasher lies with a burned-out overfill switch or a bad timer.

Testing the overfill switch

In most dishwashers, the overfill switch is part of a float assembly. This assembly, which is wired in series with the water-inlet valve and is positioned under the machine near the valve, turns off water intake if the water-inlet valve or timer fails. If this didn't happen, water could overflow the tub and cause a flood.

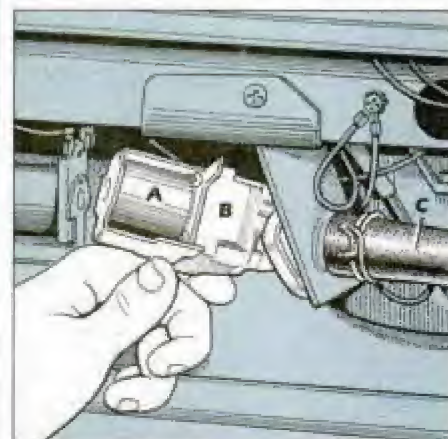
The overfill switch, however, can



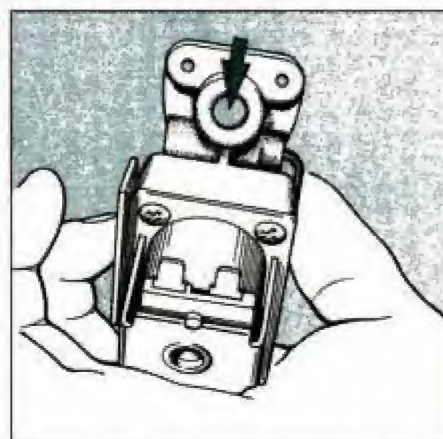
14 If the timer must be replaced, check for all attaching screws and remove them. Lift out timer and disconnect the wires.

fail in a way that results in a reverse reaction. A bad switch can keep the float in a raised position, which will prevent a perfectly good water-inlet valve from opening to allow water into the tub. So can an object wedged under the float. Therefore, before proceeding, check beneath the float to make sure a spoon or some other object isn't lying there. Then, use the float as a guide—it's inside the dishwasher, usually in the left- or right-front corner—to find the overfill switch, which will be bolted under the tub in line with the float.

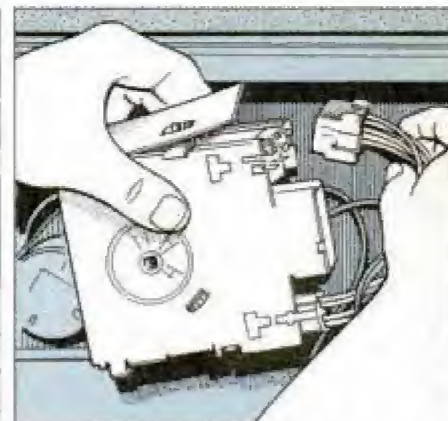
To test the overfill switch, reach up and disconnect wires from the switch terminals. Be sure to label each wire for the terminal to which it attaches. Then, hold or attach ohmmeter leads to the terminals (Fig. 12). With the float in its normal position and no water in the dishwasher, the switch should show continuity (0 ohms). With the float raised, it should show an open circuit (infinity). Anything else requires replacing the overfill switch.



16 To remove drain valve, disconnect wires from solenoid (A), unscrew valve (B) from chassis, and disconnect drain hose (C).



17 Carefully inspect nozzle (arrow) of drain valve to see if something is jamming the opening. If so, remove obstruction.



15 Install a new timer by first attaching the wires, then sliding it back into the console. Tighten mounting screws securely.

Working with the timer

Testing to see if the timer has failed necessitates that you connect the water-intake hose and wires to the solenoid, turn on the water, connect a voltmeter and turn on current. Although it isn't difficult, you will be working with live circuits and so we suggest leaving this job to a qualified service person.

You could try a different approach. After all other tests have failed, gamble that the problem is being caused by a bad timer and just replace the part (Figs. 13, 14 and 15).

Failure to drain

As mentioned before, many dishwashers have drain valves that are controlled by the timer to open at the end of the washing cycle so waste water will be pumped out of the machine. When you take off the lower access panel, a drain valve, if there is one, will be visible. Unscrew it from the chassis and disconnect the drain hose.

A drain valve is controlled by a solenoid (Fig. 16). If water does not drain from the dishwasher at the completion of the washing cycle, test the drain valve solenoid for continuity with an ohmmeter in the same way that the water-inlet valve and overfill switch are tested for continuity. If an infinity reading is shown by the meter, replace the drain valve.

In and out

Suppose instead of no draining, water comes into the machine, but it drains right out again. This fairly common occurrence is caused by debris, usually a toothpick, pit or bone that has gotten past filters and worked its way inside the valve. It can jam the valve (Fig. 17). Remove the valve and use needle-nose pliers to clear it.

FM

How To Install GLASS BLOCK

BY PAUL BARRETT; PM Illustrations by George Retseck

IT'S EASY to see why glass block has become fashionable again. It's always had unique advantages. It provides more insulating value than double-pane thermal glass, and it's easy to maintain: Just hose it down outside and wipe it inside with a damp cloth to keep it clean.

Glass block is a great replacement product for any window, but it can also be used for partitions and knee walls to admit light, and so divide a space without confining it. Block walls can be built into a kitchen island or, when installed with waterproof mortar, form a shower stall.

These are only a few examples. The versatility of this building product is limited only by your imagination.

The product

Hollow-core block is made by fusing two pieces of glass together. Standard hollow-core blocks measure 3 $\frac{3}{8}$ in. thick and weigh 20 pounds per sq. ft. So called Thinline blocks are 3 $\frac{1}{8}$ in. thick and weigh 16 pounds per sq. ft.

The blocks are sold in nominal 6-, 8- and 12-in. squares and 4 x 8-in. and 6 x 8-in. rectangles. They have a clear polyvinyl butyral edge coating so mortar bonds better. This coating also comes in black or bronze to blend or contrast surrounding materials.

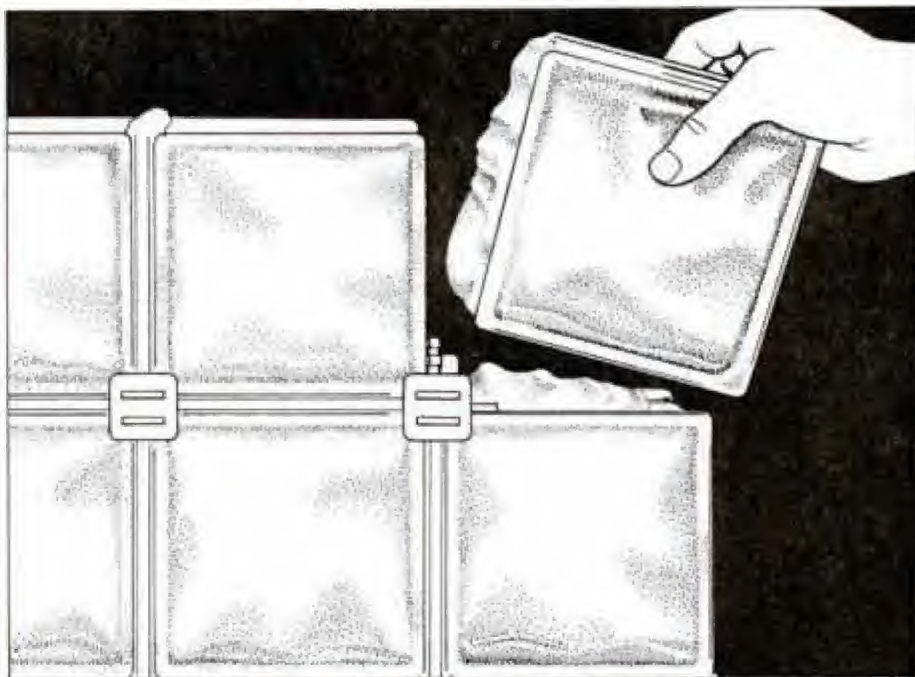
The block faces may be wavy, flat or have lined or cross-hatched patterns, all of which affect the amount of visibility through the block.

Design specifications

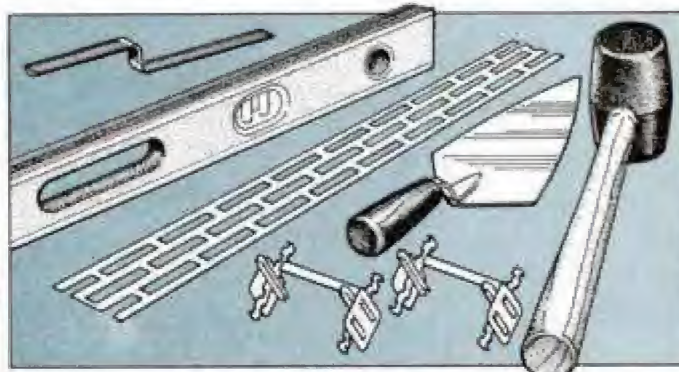
Glass block is designed for nonload-bearing walls, which means that a glass opening should not carry load from the roof or floor above. Like any window or door opening, proper framing support must surround the block.

The largest-size glass opening for an exterior wall, using standard thickness block, is 144 sq. ft.; 85 sq. ft. for Thinline blocks.

To find out other structural limitations, contact the manufacturer (Pittsburgh Corning Corp., 800 Presque Isle Dr., Pittsburgh, PA 15239) and your local building department.



Only a few basic tools are necessary to work with glass block (left to right): a jointing tool (for smoothing mortar joints), a level, perforated metal anchor strip (to tie block to adjoining walls), a trowel, joint spacers, a rubber mallet (to tap block in place without damage).



Installation

Glass blocks are laid up with mortar like other masonry products. There are, however, a few important differences. Don't furrow the mortar bed between blocks with the trowel's point. This risks introducing air pockets into the joint.

Lay the mortar smooth and place the blocks on it. Also, seal the base of the opening by brushing on asphalt emulsion sealer, available at masonry supply stores.

The standard mortar mix is 1 part Portland Cement, $\frac{1}{2}$ part lime and 4 parts sand. Thoroughly dry mix these ingredients and add only enough wa-

ter to make for a crumbly mixture. For exterior walls and shower stalls use waterproof Portland cement or a waterproofing additive.

The blocks are laid in the following sequence. After the asphalt emulsion has dried, lay down a mortar bed, and place the first block. Level and plumb it in place, tapping it into position with a rubber mallet. Set a joint spacer on one corner (Fig. 1). Apply mortar to the vertical edge of the next block and repeat the process (Fig. 2). The joint spacers should help keep mortar joints consistently $\frac{1}{4}$ in. thick.

After a row is laid up, trowel off the mortar squeezed from the joints (Fig.

3). Trowel a bed of mortar on top of the row and repeat the process (Fig. 4).

When the wall is finished, twist the fronts off the joint spacers and trowel over the small void left in the mortar (Fig. 6). While the mortar is still workable, smooth the joint with a jointing tool (Fig. 7).

Exterior glass block walls are strengthened with 10-ft. lengths of

reinforcing wire buried in horizontal joints. Install the wire at 24-in. height intervals for standard thickness block and 16 in. for thinline block. Omit this in all but very large interior walls.

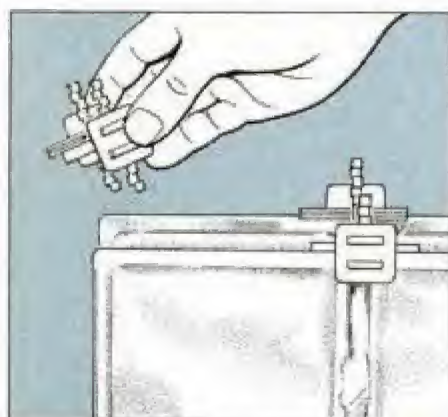
Perforated metal anchor strips, 24 in. long, are embedded in the mortar joint at the same intervals as the reinforcing wire. Bend the anchor strips so half their length is buried in the

mortar joint and the other half abuts the surrounding surface. Nail or lag-screw the strips to the surface.

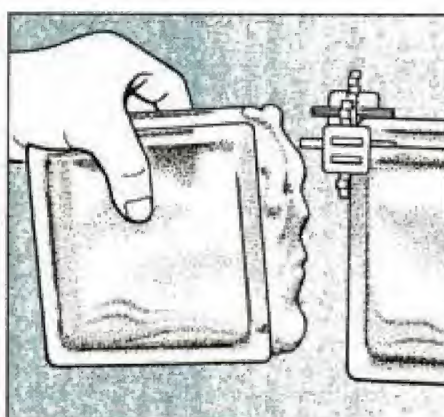
Because glass expands and contracts with temperature changes at a different rate than wood or masonry, it's necessary in some cases to provide expansion strips to cushion the glass block where it abuts adjoining surfaces. The expansion strips are stapled or glued down with asphalt emulsion. Run the strips vertically where the block wall ties into adjoining walls, and horizontally along the wall's top. When the wall is completed, caulk the corner where the glass block meets the adjoining surface.

Omit the expansion strip on exterior walls smaller than 25 sq. ft. and on interior walls, unless you want to provide a backing for the caulk at the wall's corner. Peel back the expansion strip so the perforated anchor strip can be applied directly to the adjoining surface.

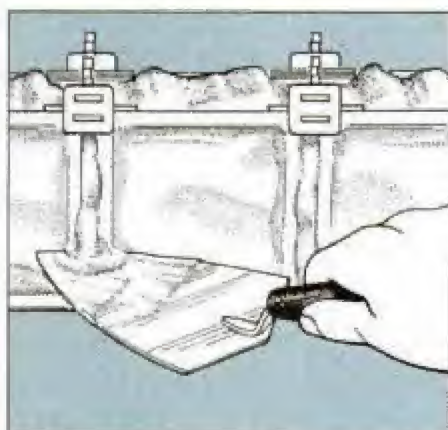
Finish the wall by brushing off mortar spatters with a damp brush, then wipe the wall with a cloth (Fig. 8).



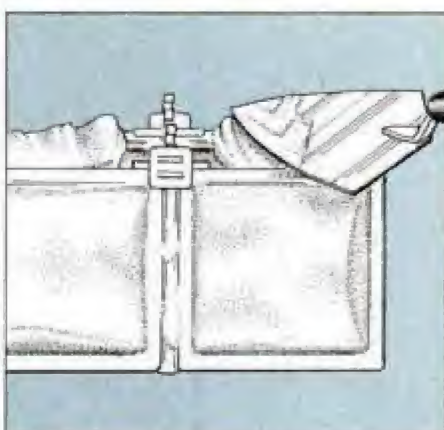
1 Joint spacers help maintain a consistent mortar bed. Place one on each block corner before laying the next block.



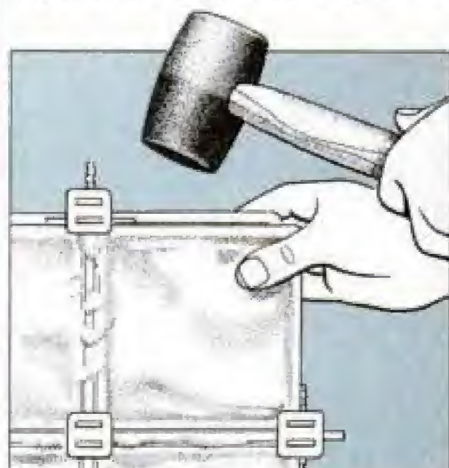
2 Apply mortar to the vertical side of the ensuing block, then slide the new block up against the previous block.



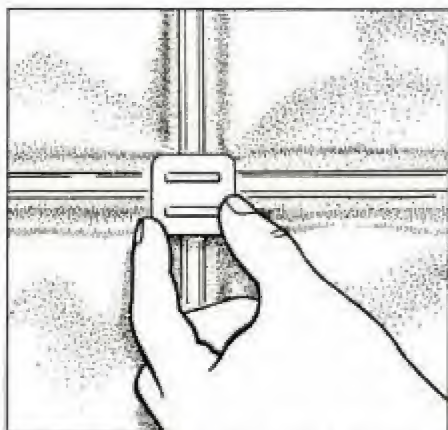
3 When the excess mortar squeezes from between the block, remove it, while the mortar is still soft, using a trowel.



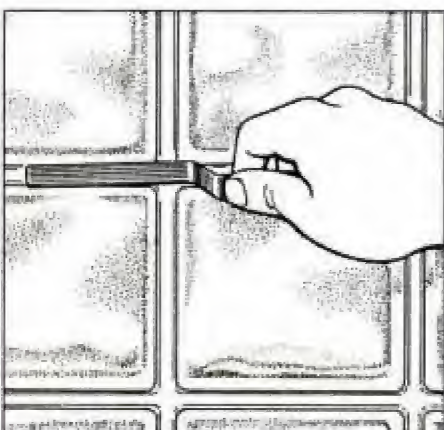
4 Smooth mortar flat—don't furrow it—on top of each block. Keep mortar clear of the arms on the joint spacers.



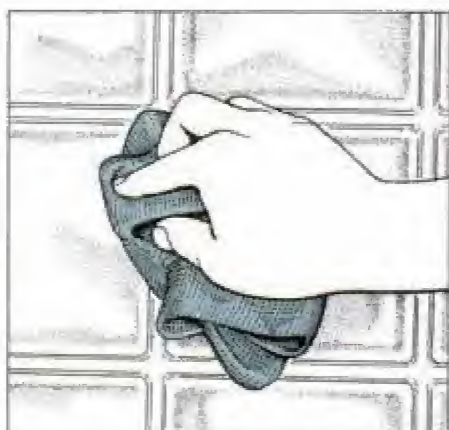
5 To avoid chipping or cracking, tap glass block into place gently, using a rubber mallet or the heel of your hand.



6 Twist off each joint spacer. Then fill the small gap left behind with mortar. Smooth the mortar flush with a trowel.



7 To ensure a tight, smooth joint at the edge of each block, work the mortar while still soft using a jointing tool.



8 To finish a glass block wall, clean away mortar spatters with a damp brush. Then wipe the wall clean with a soft rag.

Homeowners' Clinic

BY NORMAN BECKER, P.E., Contributing Editor

Fire Extinguishers

I want to buy a fire extinguisher for my home but don't know which type to get.

CHRIS MCLELLAND
OWINGS MILLS, MD

This is a good question because using the wrong type of fire extinguisher could do more harm than good. It must suit the type of fire that's burning.

There are three types of fires. Class A fires are those involving ordinary combustibles such as wood, paper, cloth, rubber and so on. Home fires of this type often start in the living room or bedrooms. Class B fires involve cooking oils, grease, gasoline, paint thinners and other flammable liquids. These fires generally break out in kitchens and garages. Class C fires are electrical fires and are usually the result of faulty wiring, overloaded circuits, short circuits or faulty electrical appliances.

On fire extinguishers, these categories are designated by the letters A, B and C within a triangle, square and circle, respectively. Class B- or BC-rated extinguishers are not effective on a Class A fire. Also, water which is effective in extinguishing a Class A fire will cause a Class B fire to spread and can cause a severe shock in a Class C fire. Once a fire in the home spreads, it can quickly include all three categories. Therefore, your best choice is a fire extinguisher rated for all three classes of fire.

Fire extinguishers are available at hardware stores and home centers. When you buy one, check to see that it's listed by Underwriters Laboratories, Inc., and displays the A, B and C designations. Also, note the numbers in front of the A and B designations. These refer to the size of fire that the extinguisher can generally handle. The numbers are not absolute figures, but are relative terms for comparing different units. For example, an extinguisher with a rating of 2A:40B:C will handle a Class A fire twice as large, and a Class B fire four times as large, as a unit rated 1A:10B:C.

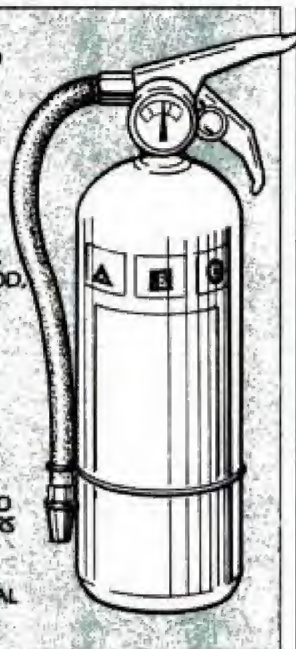
Note that there are no size ratings for Class C fires. The C designation only means that the chemical inside will not conduct electricity.

LETTER AND SYMBOL CODE:

A
FOR FIRES INVOLVING COMBUSTIBLES SUCH AS WOOD, PAPER AND CLOTH

B
FOR FIRES INVOLVING FLAMMABLE LIQUIDS SUCH AS GREASE, GASOLINE AND PAINT THINNERS

C
FOR ELECTRICAL FIRES



To be safe and effective, fire extinguishers should be matched to the type of fire. Unit rated ABC is best for home use.

Removing Caulk

The previous owner of my house used silicone caulk on everything in sight. How can I get it off?

IKE MAROHN
LAKEWOOD, CO

The most common solvent for silicone caulk, as recommended by the Silicone Division of General Electric, is isopropyl alcohol. If that doesn't do the job, you can try a stronger solvent such as a paint thinner that contains Xylene.

Damp Basement Closet

I hope you can help me with a very aggravating problem. About a year ago, I built a closet in the basement to store our clothes in the off-season. Our summer clothes were stored last winter and they were fine this spring when I took them out. However, when I retrieved our winter clothes which had been stored for the summer, I found them full of mold and mildew. How do I solve the problem?

DAN BACHRACH
LONG BRANCH, NJ

Basements, because they are below grade, are cooler in the summer than

the rest of the house. As a result, the moisture in the humid summer air tends to condense in the basement making that area quite damp. This, in turn, promotes the growth of mold and mildew. Opening the windows and using a fan to circulate the air will only work when the humidity of the outside air is not as high as it usually is in the summer. And, the problem is compounded in a closet because of the confined space and stagnant air.

The best approach is to install a dehumidifier in the basement. While it's not practical to place it in the closet, you can install vent openings in the top and bottom of the closet door to help circulate the basement air.

Another approach is to use chemicals that absorb moisture such as silica gel and activated alumina. These have the capacity to absorb half their weight in water. They can be placed in the closet in a bucket or cloth bags hung from the closet pole. After they've become saturated, the water can be drawn off by heating and the chemicals can be reused.

Wasted Water

Water is a natural resource that many people take for granted—until there's a drought. Conservation of this resource isn't only concerned with usage, but also with the elimination of leaks in a plumbing system. The following chart illustrates just how much water will be lost through various size holes over 3 months. The figures are based on an average household water pressure of 60 psi.

Diameter of stream, in inches	Waste after 3 months, in gals.
1/4	1,181,500
1/8	296,000
1/16	74,000
1/32	18,500

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

Just ask Norm about it. Send your question to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Appliance Clinic

BY STEVE TOTH, Contributing Editor

Cold Flows Slowly

I have a Whirlpool washer model No. LAA5800A7, serial No. C52501865. Although the hot water enters the machine at a good rate, the cold flows much slower. When I select warm water for a wash, it's much too hot.

MICHAEL BAIAMONTE
PHOENIX, AZ

At the back of your washer is a blue plastic valve to which the hoses are connected. This is the water fill valve. When you select a warm wash, this valve mixes the two incoming water temperatures at a ratio of 60-percent hot water to 40-percent cold.

What probably happened is the cold-water filter screen, and possibly the inside of the hose itself, has become coated with mineral deposits which restrict the flow of water.

To fix the problem, first shut off the faucets that supply water to the machine. Set the control for a warm-water wash and turn the machine on. When the water stops entering the tub, turn off the washer and unplug it. Next, remove the cold-water hose from the faucet and fill a bucket to flush the pipe.

If you have a filter screen where the hose connects to the faucet, clean it or replace if necessary. If you don't have a screen at this point, then add one. Note that the cone-shaped screen should point toward the faucet. Reconnect the hose and remove the other end from the washer fill valve.

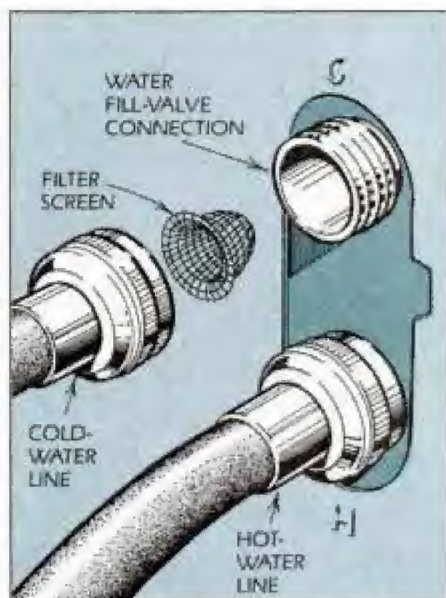
Carefully pry the screen filter from the valve and clean. Reassemble the screen and hose and turn on the water to check for leaks.

Plug in the washer and make a test run. You should notice a difference immediately. If, over a period of time, the problem reoccurs, you'll have to clean the filter screens again.

Oven Weeps

I am having a problem with my Roper built-in oven model No. 2041B40, serial No. 4M01554. When I do any baking or roasting, moisture condenses on the floor of the oven and under the door. I have to wipe it up several times before the food is finished.

JOSEPH D. WILLIAMS
FRISCO CITY, AL



Clogged cold-water filter screen can make warm-water washes too hot. Remove hose from washer, pry out screen and clean.

To correct this problem, the Roper Co. offers an auxiliary fan kit (part No. 4342545). The fan is mounted in the console area above the oven. A hole is cut near the back of the console and a vent tube and baffle are added. A new thermostat that controls fan operation is also installed.

The thermostat turns on the fan when the temperature in the console reaches 100° F to 108° F. The resultant increase in air circulation eliminates the condensation.

The fan kit must be installed by a factory-authorized technician. To get the name and phone number of your nearest Roper service company, call the Roper Co. at (800) 447-6737.

Lint Slips Through

Although I've had my Maytag washer model No. A408, serial No. N2238692 since 1978, the lint filter has yet to catch any lint. Why isn't the lint filter in the machine doing the job?

CHRISTINA GULRICH
SARATOGA, CA

This is not an unusual occurrence. The lint filter in the center of the agitator only supplements the main filtering system. In normal use, the tub is spinning at slow speed when the water is draining. All lint and dirt

floats over the clothes, out through the holes in the tub and down the drain. Unless you're washing towels, rugs or other lint-producing items and the machine is set for a large or extra-large wash, the lint filter won't catch much lint.

Normally, the amount of lint and soil that's discharged shouldn't cause any trouble with the drainage system. However, if you think it is a problem, you can install a stocking or soft, metal mesh bag over the end of the drain pipe to catch the lint.

Sewing Machine Parts

I'm looking for parts to repair my White Rotary sewing machine model No. 77-161621. Can you help?

HARTMON SULLIVAN
POLLOCK, LA

First, check your local Yellow Pages under sewing machines. There may be a dealer in your area who can help.

If not, then contact the Viking-White Sewing Machine Co., 11760 Berea Rd., Cleveland, OH 44111, phone: (216) 252-3300. Ask for the parts department and supply them with the model number of your machine and the parts that you need. They'll inform you of the specific part numbers and prices. You can then send them your order along with a check or money order to cover the parts and shipping. **PM**

Service Tip

For those who own one of the newer direct-drive Whirlpool washing machines and are interested in doing their own repairs, Whirlpool Corp. has recently published a repair manual specifically for direct-drive washers. It's available from Whirlpool dealers and parts distributors for \$7.50. To order by mail, send \$8.50 to General Accounting, Whirlpool Parts Distribution Center, LaPorte, IN 46350.

DO YOU HAVE AN APPLIANCE PROBLEM? Just ask Steve about it. Send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.

LONG-TERM TEST



COBALT CONDURRE 223

Our long-term test finds a touch of class in a slick and quick sport cruiser.

BY JOE SKORUPA, Boating/Outdoors Editor; PM Photos by Humphrey Sutton

COMEDIAN George Carlin could have some fun with the boating term *overbuilt*. Too much building. Must be bad, right? Not in boating.

A wordist (combined form of wordsmith and humorist) would no doubt point out that overbuilt is the other side of the coin to military intelligence, which Carlin explains is a term that means less than it implies, since the first word tends to cancel out the second. On the other hand, overbuilt (or overbuilt, as it is usually used) means *more* than it suggests. It refers to a boat that *exceeds* the minimum requirements for safety and durability. In other words, it's built to last well beyond the warranty period.

Which brings us to Cobalt, a Neodesha, Kansas-based company with a well-deserved reputation for crafting overbuilt boats. Last summer I had the distinct pleasure of babysitting a sporty Cobalt Condurre 223. I had it for six weeks and used it on the waters of Lake George, Greenwood Lake and the Great South Bay of Long Island,



Tightly clustered gauges highlight helm.

all in the state of New York.

I was intrigued by the 22-ft. Condurre ever since PM's sport-cuddy comparison test. (See "Family Flyers," page 68, July '88.) Out of a fleet of five similar boats, all top names, the Condurre came out the leader in all performance categories plus fit and finish. In addition, it scored solidly across the board and easily walked away with the winner's crown.

I was anxious to learn more about this winning boat and about the company that built, or overbuilt, it. Here's what I found.

Leading the way

Condurre is an Italian word meaning "to lead," which is appropriate for a boat that's several steps ahead of the competition. Cobalt began the Condurre line, designed by Peter Granata of Hilton Head, South Carolina, in 1986. No one can doubt that the 223 is a stylish boat. The sum of its parts adds up to a pleasing whole—raked, wraparound windshield, reverse transom with integrated swim platform, tasteful teak trim, rich upholstery, understated colors and among the smoothest gel coats in the business. But what makes it overbuilt?

"God is in the details," said architect Mies van der Rohe and paying attention to the little things is where you separate mass-produced rigs from limited-production boats.

Consider the complex geometry of the transom area, with its molded character lines and indents. This is a style rarely achieved in noncustom boats because it takes valuable production time to squeeze the fiberglass

(Please turn to page 100)



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COBALT CONDURRE 223 (Continued from page 99)

into the offsets, and even more time for the hull to dry in the molds.

Hull and deck molds, in fact, are cleaned and waxed after every use. They're checked for uniformity and hand-polished after every 10 boats.

Each boat stays in the mold to cure for three to four days, a long time considering that many boats of this size are fully completed in the same length of time. This care and attention to quality during the lamination process creates Cobalt's luxurious finish, the company's trademark.

Start to finish, a Cobalt takes up to 12 days to build, which is about double for many other builders of comparably sized boats.

Water trials

While I never ran the Condurre in rough, offshore water, I experienced enough wind and chop to appreciate its strength and stability. The hull's well-hardened, bulletproof lamination exudes a feeling that it can take anything nature can throw against it and never slacken the pace.

And the pace can be quite brisk. The test boat was powered by a Merc big-block, 454-cu.-in. engine with a 4-barrel carburetor and a high-performance Bravo One vertical drive. The 7.4-liter Merc pumped out 330 hp and enough torque to push the Condurre to 57.4 mph on calm water.

One reason for the Condurre's outstanding performance is its sharp 20° V-bottom hull, which knifes through the rough stuff, tracks straight and true, and corners like a roadster. I tried my best to discover any tendency of hull misbehavior, but the Condurre passed each torture test with flying colors.

Turn of the screw

The importance of the prop in power delivery was once again underscored for me last summer. After picking up the Condurre at Marineland's Greenwood Lake marina, which did a superb job of prepping the boat, I was surprisingly disappointed by the boat's performance. Only six months earlier I'd tested a 1988 model—featuring identical hull and engine—and the boat jumped on plane swiftly and cleanly.

This boat, a 1989 model, blasted off bow high and cornering was now severely limited. The boat displayed a tendency to come off plane in tight turns and a reluctance to pop back up again unless brought to a stop.

I called a friend at Cobalt and told him the story. He said, "The boat you drove last year had a 23-in. pitch stainless-steel prop. The boat you have now is equipped with a standard

23-in. aluminum prop, which is how we ship boats."

After I installed a new stainless wheel, my test winner was back. The Condurre now displayed its familiar bow-down hole shot and firm prop-bite in all cornering situations.

I drove several hundred miles between the two lakes and one bay where I tested the Condurre last summer. These miles—many on high-speed highways, others through urban streets—were handled by four excellent Ford tow vehicles—Bronco II, full-size Bronco, Aerostar and Econoline Club Wagon.

Despite the heavy load (just under the 5000-pound limit), the tow vehicles had no trouble coping with rough-and-tumble launch ramps or steep hills. While all vehicles fulfilled everything asked of them, my personal favorites were the Aerostar minivan, with its 3.0-liter V6 engine and extended length van, and the full-size Bronco, equipped with 5.0-liter V8 and touch-drive 4wd shifting. Both vehicles came with the upscale Eddie Bauer trim-and-features package.

As mentioned earlier, the Condurre is a stylish boat that exudes a feeling of quality. Among its outstanding features are hydraulic engine hatch lid, black anodized dash panel with tightly clustered gauges, and immense sunpad. The plush cuddy, although small, is completely carpeted and has a V-berth, wet bar and two hatches for ventilation.

In the you-can't-do-it-all category, I suppose I could quibble with a few design decisions. By keeping the foredeck flat for a sporty profile, the cuddy area is limited to little more than crawl space. While stowage space is acceptable, totaling 34.45 cu. ft., some boats this size have nearly double the capacity. And finally, the raised gunwale, which flows smoothly into the windscreen, makes for such a high freeboard that entry/egress is a bit of a problem.

More than one person I met last summer commented that Cobalt boats are the "Cadillac of their class." Part of that reputation is the result of what I've referred to as overbuilding. Naturally, this attention to detail costs a little more (\$31,457 for the Condurre 223 with 7.4-liter Merc) but the end result is a hull and deck with a 5-year transferable warranty and a 2-year warranty on virtually everything else.

As industrial designer Peter Granata says, "No one calls a piece of art overbuilt. A product can be said to be overbuilt, but not a work of art. I don't think of a Cobalt Condurre as a product. It's something more." **PM**

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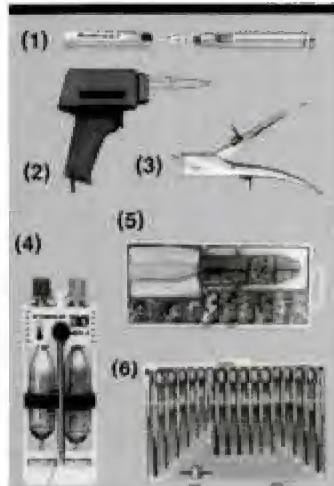


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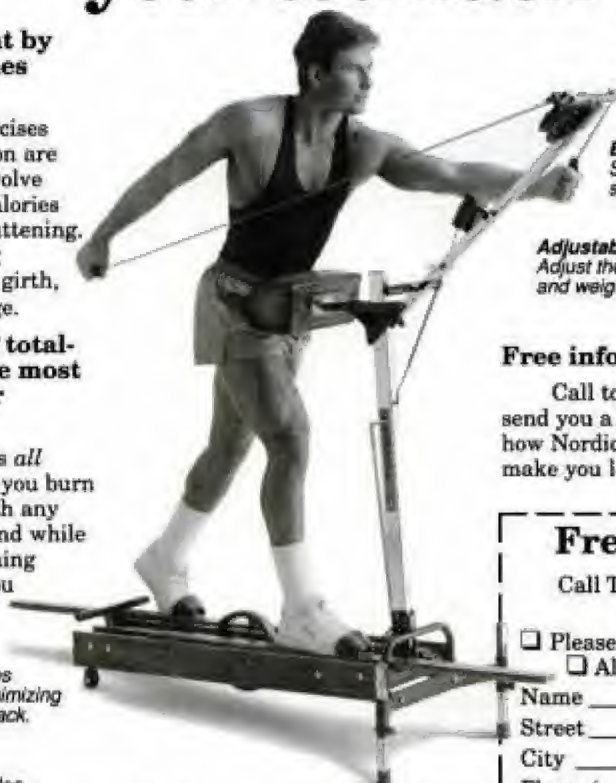
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SUPER SUBURBAN

BY LEN FRANK; PM Photos by Ron Hussey

THE NEWS IS that you can now buy a GMC Suburban, Jimmy, Bonus/Crew Cab pickup, or cab and chassis equipped with a Gale Banks Engineering turbocharged 6.2-liter diesel engine. The big news is that you can now buy it right at your GMC dealer—unless you live in California.

So what? Well, try a 40 percent increase in power and a 15 percent increase in fuel economy as a result of the turbo system. Power is maximized between 1400 and 2800 rpm—right where it's most useful. Too good to be true? If so, why then hasn't GM done it themselves? Why did GM have to go to an outside vendor like Gale Banks Engineering? There is no question that the light-duty diesel is in decline in the U.S., attacked both by increasingly tough emissions standards and the increasing price of diesel fuel. The 6.2 engine,

for instance, with or without turbo, is not legal for sale in California in trucks under 8500 pounds gross vehicle weight (GVW) nor are any passenger car diesels. The future fate of diesel engines is unknown. So it doesn't pay for GM to invest millions in further development of the engine. But that doesn't mean there isn't a payoff for someone else to do the development.

Gale Banks says that the 6.2, which he has been turbocharging since 1982,

is a clean-sheet engine designed from scratch, unlike some failure-prone V8 gas engine conversions that so many would like to forget. Also that it's the natural thing to do with the engine, resulting in more available torque and better economy. So now General Motors has the diesel they should have had in the first place.

While the Banks turbos are available on new GMC trucks and Suburbans through the dealership network, they are not precisely OE. The GM

warranty still covers everything it normally would. The turbo and its related parts have their own Banks-backed 12-month, unlimited-mileage policy.

When a GMC is ordered with a Banks turbo, the vehicle is shipped from the plant to a subcontractor in Almont, Michigan, where the turbo installation is made. From there it goes back to

(Please turn to page 107)



Banks turbo hardware is available in the Suburban as a kit, but it's easier to just check a box on your order blank.

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VOYAGER'S ENCOUNTER

(Continued from page 53)

Data collection

The Jet Propulsion Laboratory sends and receives data from *Voyager 2* via the Deep Space Network, an array of huge dish antennas scattered around the world. DSN installations are located in the Mojave Desert, outside Madrid and in a remote place called Tidbinbilla near Canberra, Australia. Each installation has three antennas, all of which may be used to communicate with *Voyager 2*.

In anticipation of the spacecraft's Uranus and Neptune encounters, the largest antennas were enlarged from 64 meters diameter to 70 meters (contributing to the \$556 million price tag for both *Voyager 1* and *Voyager 2*). Data reception for the Neptune encounter will be augmented by a 64-meter dish at the Parkes Radio Observatory near Canberra, which will supplement the work performed at Tidbinbilla.

Similarly, the 27 25-meter antennas of the Very Large Array, located at the National Radio Astronomy Observatory near Socorro, New Mexico, will work with the California DSN station. The 64-meter Usuda Tracking Station owned by Japan's Institute of Space and Astronautical Science is also scheduled to obtain

radio science data on Triton and Neptune.

Mission profile

People and machines will be poised on August 24 as *Voyager 2* follows a mission profile calculated more than eight years ago. The flyby is not without uncertainties. Neptune hasn't made a complete revolution of the Sun since its discovery in the mid-19th century, which means the exact period of Neptune's orbit—crucial to precision navigation—is still not known. Scientists also don't know how much Neptune weighs, and, by extension, how Neptune's gravitational attraction will affect *Voyager 2*'s trajectory.

But if all goes according to plan, JPL will issue *Voyager 2* final instructions to pass within 3000 miles of Neptune's north pole—closer than any other planetary encounter, but not close enough to feel the effects of Neptune's atmospheric drag. The flight path will give astronomers a close view of Neptune's hydrogen/helium/methane-rich outer shell, but will also avoid Neptune's half-rings. Final stop will be Triton—Pluto's cousin?—and the deep space beyond.

At that point *Voyager 2* will cease being the eyes of man on Earth, and will assume a new role as our emissary to the Cosmos.

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Model Steam Tractor—Challenge of a lifetime! The famous J.I. Case threshing machine steam tractor. The finest detail work, explained on 16 separate plans sheets plus instruction booklet. Stacks firewood but burns alcohol. 9 separate gears in the transmission alone. What a thrill to see it go under its own power. (PA-1272—\$11.95)

The craft's double-wall monocoque fuselage incorporates a central aluminum I-beam, bolstered by an alloy-tube outrigger. All flying surfaces are composite carbon fiber and Nomex paper honeycomb. The wings have full-length flaperons, and the horizontal stabilizer stands below the prop centerline to minimize any potential harmonics. All controls are manual, minus hydraulic or power assist.

If all goes well, Bill Montagne hopes to begin flight testing out of Livermore, California, later this summer. He calculates that he'll have about \$473,000 invested in the aircraft when it's finished. Several potential new sponsors are monitoring progress.

Meanwhile, there's a lot of work to be done as one more lone aviator challenges the limits of the sky.

Book Review: Freefall

William Hoffer, author of *Midnight Express* among many other successful non-fiction titles, is a frequent contributor to **POPULAR MECHANICS**. Planes and trains have always held Hoffer's interest. He wrote "Horror In The Skies" for *PM*'s June '89 issue (page 67), the story of our nation's aging aircraft. He also wrote "Born Again," the May 1989 piece (page 117) that chronicled the rebirth of America's favorite steam railroad locomotives.

Last year, Hoffer turned another *PM* feature into a nonfiction work that may rival the great aviation stories of all time. In *PM*'s April 1984 issue (page 77), Hoffer wrote an article called "We Made It!" which spotlighted several heart-stopping near-misses in commercial aviation. One incident involved an

Air Canada Boeing 767 that made a miraculous dead-stick landing at an abandoned Canadian airfield after its crew miscalculated the airplane's fuel supply. In his new book *Freefall* (St. Martin's Press), Hoffer describes in careful detail the actions by maintenance personnel, refuelers and flight deck officers that contributed to the near-demise—and miraculous recovery—of Air Canada flight 143 on the early evening of July 23, 1983. He also gives a gripping account of what the passengers experienced on a flight that the experts said could never happen.

The first impossible: A faulty fuel gauge system forced the aircraft's refuelers to calculate fuel load manually. Confusion over converting the load from kilograms to pounds caused flight 143 to roar into the dusk 26,000 pounds short of fuel. At 41,000 ft., over Red Lake, Ontario, first one engine failed. Then another. Soon, robbed of generating power, Capt. Bob Pearson's glass instrument panel went black, his airliner inadvertently turned into a glider.

It was now up to Capt. Pearson and First Officer Maurice Quintal to maneuver the airplane, freefalling at 2000 ft. per minute, to a dead-stick landing.

The aircraft landed safely, thanks to the second impossible that evening—Bob Pearson actually was a skilled glider pilot. Hoffer expands the 20 minutes from engine out to landing with a fascinating study of one of our most modern airliners, weaving technical detail and emotional trauma into a gripping account of modern air travel.

It's a good book, and it all started with **POPULAR MECHANICS**.

—Tim Cole

SUPER SUBURBAN (Continued from page 104)

the plant for shipment to the original selling dealer.

The Banks turbocharger system starts by taking in cool outside air. The cooler the air, the denser the charge and the greater the power increase. The air then goes through a reusable gauze filter to the Banks-Schwitzer turbo. Banks has specified a lightweight Inconel turbine wheel and a split air outlet scroll, similar in principle to dual runner inlet manifolds designed to keep airflow velocities high. This improves pedal response. The air duct from the turbo to the manifold increases in size as it gets closer to the manifold, helping to convert air velocity to air pressure. The manifold plenum is extra-large in capacity (three cylinders worth), as a further aid to response.

Diesels, of course, run without throttle butterflies. So when the driver pushes on the loud pedal, it's only additional fuel being added. Banks

says that the original injection pump is easily modified to provide the extra charge. He also says that rich mixtures are to be avoided. A leaner mixture not only aids power and keeps temperatures under control, it improves fuel mileage. Ideal is 5 percent to 7 percent air above stoichiometric.

The Banks exhaust system reduces back pressure from 7.0 pounds at full boost to 0.5 pounds. And back pressure is the enemy of turbo boost. A transmission cooler is suggested for towing, but no additional engine cooling is needed.

Price for the turbo is estimated at \$2500 at a GMC dealer. If you already own a 6.2, you can buy a kit for \$1995 plus \$259 for the exhaust system. Retrofitting a system is a 10- to 12-hour job for an experienced mechanic, according to Banks. It's a heck of a lot easier to walk into a GMC dealer and check off the appropriate box on the order blank.

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WAR HORSES (Continued from page 59)

the next event, the Tour de France, Proctor won and Harper was second in the Touring class—the first big Mustang victory.

The Mustang rally cars made a great splash in Europe, even inspiring the Academy Award-winning movie, *A Man And A Woman*, in which real-life racer Jean-Louis Trintignant plays a Ford Mustang rally driver in love with racing and Anouk Aimee, in that order.

Carroll Shelby's G.T. 350R racers were essentially the same as the Comstock Mustang built six months earlier, except the Shelseys were fastbacks rather than notchbacks.

Shelby's one brilliant idea was to remove the rear seat. If a car with four seats was a sedan according to the SCCA and FIA, then a car with two seats had to be a sports car. Porsche later took advantage of this same rule by putting a back seat into the 911, making it a diabolically fast sedan. Taking the seat out put the G.T. 350R into SCCA's B Production category, where it promptly began making a name for itself.

Shelby's friend Jerry Titus, then editor of *Sports Car Graphic*, captured the Mustang's first U.S. championship, taking the B Production title in 1965. Walt Hane won it in 1966 and Freddie Van Buren won in 1967. In those days, the only competition came from '62 and earlier Corvettes and Lotus Elans, which were no match for the Shelby Mustangs.

There was also a drag-racing version of the G.T. 350R, which first competed in August, 1965. The best quarter-mile times for any G.T. 350 was 12.68 seconds, according to Shelby authority Rick Kopec. The real Mustang drag cars were factory cars that raced in A/FX. These were the forerunners of funny cars. The Mustangs had fiberglass bodywork, an altered 112-in. wheelbase, and a fuel-injected 427-cu.-in. overhead cam V8. Driven by Gas Ronda and others, these cars eventually hit 165 mph in the quarter-mile.

In 1966, the SCCA discovered sedan racing. Amateurs raced in SCCA's A Sedan class. Professionals raced in a new series called the Trans-American Sedan Championship, or Trans-Am. Shelby built 20 Group 2 sedans in 1966—essentially notchback G.T. 350Rs.

Since all the racing parts were available through any Ford dealer, there were also dozens of identical Mustang Group 2 sedans built by private teams. Mustangs amassed enough points to win the first Trans-Am championship.

In 1967, Shelby raced two factory

cars in the Trans-Am. Though they used the restyled Mustang body, mechanically they were derived from the previous G.T. 350Rs and Group 2 sedans. Shelby's cars won the championship over the Bud Moore Mercury Cougars by one position in the last race of the season. It was the last Trans-Am victory in many years for Mustang, as the series was dominated by the Penske/Donohue team for the next several years.

At this point, factory support for the Trans-Am dried up and Mustang racing essentially evaporated. In fact, the Ford Motor Co. was all but out of racing throughout the decade of the 1970s.

The current Mustang has been extremely successful as a race car. In the early '80s, Mustang racing was placed under the direction of Michael Kranefuss of Ford's Special Vehicle Operations (SVO) department and the emphasis was on small turbocharged engines rather than big V8s.

These early '80s Mustangs ran in IMSA International Sedan races with turbo 2.3-liter engines and without much success. However, in 1981, Klaus Ludwig's Zakspeed firm built an IMSA GT car that was called a Mustang but was actually more German Ford Capri. It was built around a 1.6-liter dohc turbocharged Four rated 560 hp. The rest of the 1800-pound Kevlar/carbon-fiber package was equally exotic. It looked a little bit like a Mustang, if you squinted real hard. But the Zakspeed Mustang GT was actually a pure racer, capable of 185 mph and, more importantly, winning races.

So was the Mustang GTP car Zakspeed developed for IMSA in 1983 and '84. A purpose-built race car that just happened to be called a Mustang, the Mustang GTP won its first race, but struggled after that. Ludwig was regularly the fastest qualifier, but the overstressed turbo Four always broke before the finish. The Mustang GTP does have the distinction of being the last competitive front-engined GTP race car, though.

In 1985, Wally Dallenbach Jr. won another Trans-Am title for Ford, and Scott Pruett added the IMSA GTO title in '86, repeating in 1988.

During this period, Showroom Stock racing titles had largely eluded the Mustang—with two notable exceptions. In 1987, Steve Saleen's Mustangs took the SSGT class in the Escort Endurance championship. And there was the POPULAR MECHANICS win in the 1988 Longest Day of Nelson 24-hour race—one of the few overall victories for a Mustang in any kind of endurance racing. **PM**

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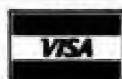
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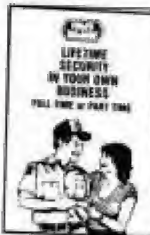


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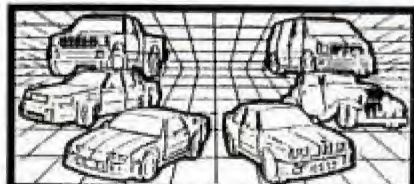
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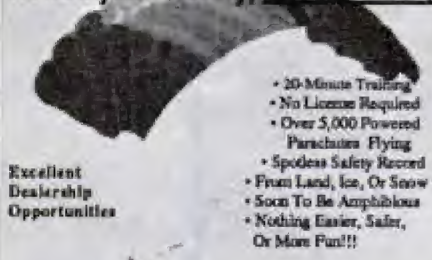
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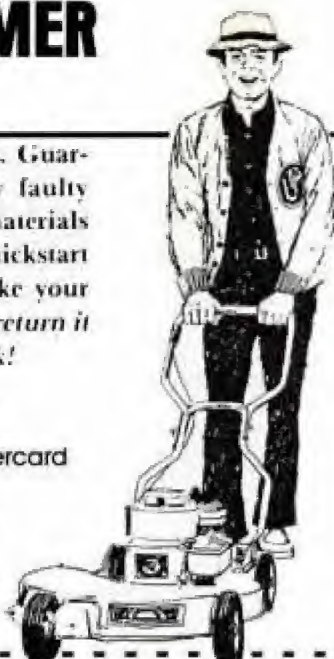
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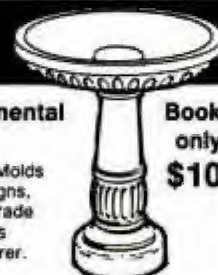
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